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Civil Engineering.

Cost of Transportation on Railroads. By CHARLES ELLET, Jr., C.E.

(Continued from Page 8.)

Wear of Iron rails.—It was not my intention to deviate from the course which I had marked out as proper to be observed in the discussion and development of the important subject which I have attempted to exhibit, for the purpose of disposing of collateral points, or of refuting any objections that might be urged against my argument. But the matter presented in the December number of the Journal is of such deep interest to all concerned in the rail road cause, that I have been compelled to make frequent oral explanations and estimates, which could be more advantageously and more appropriately offered in their place in these articles. I propose, therefore, to recur briefly in the present paper, to the momentous question of the probable durability of the iron rails, and the pecuniary loss consequent on their destruction, for the purpose of presenting facts which it was my wish to postpone to a later period.

It is as impossible as it would be dishonest to attempt to promote the cause of internal improvement, or any division of that cause, by deceptive estimates or the expression of extravagant hopes. It is the duty of the engineer, as well as of the statesman, to look at things as they are, at this great system as it is. He must first recognize the weak points before he can hope to fortify them. If companies or their officers, fail to estimate their expenses truly, they will inevitably fail also in their great objects, and instead of bringing blessings and prosperity into the country, public improvements will continue to be, as they have hitherto frequently been, the bearers of private ruin and public dishonor.

The prevailing fault of all writers on rail road policy is that of yielding up their judgment to the dictation of their wishes, and exhibiting the facts as all desire them to be, and not as we find them. Hence the proverbial errors of companies and their agents, in undervalueing the first cost of their work; in over estimating its business, and underrating the cost of its maintenance. Their opinions are but the picture of their hopes, and rarely deductions from an extensive and systematic investigation, and a wide experience.

But we are now in pursuit of truth and shall endeavor to avoid this error.

The rail road system is new. It is not yet twenty-five years since the locomotive engine has been used with any decided success, and it is not fifteen years since its first employment on lines of general and extensive intercourse.

We have, nevertheless, much experience of the wear of iron rails; for a heavy trade—a trade vastly inferior to that of some of the canals of this country—is sufficient to produce great and obvious effects in a very brief space of time.

We cannot seek this experience, however, on the great rail ways recently finished in England. These carry but little freight. Their business is nearly confined to the conveyance of passengers; and though they really transport many tons of parcels and costly merchandize, and make a considerable show of business, the actual tonnage, compared with that of some of our important canals, is insignificant. Indeed, the public have not yet become accustomed to compare the actual weight of the trade which is transmitted along existing lines of rail roads, and that which passes noiselessly through the old canals, and there are consequently few who have yet formed a just conception of their relative magnitudes.

The *London and Birmingham* rail way has already cost about $30,000,000; and was graded with a view to the heaviest traffic; but the speed and accommodation which it offers are but slight compensation for the price of carriage at which they must be purchased. With all the labor bestowed upon this work; with all the outlay encountered to reduce the cost of transportation—the annual net tonnage upon it is not greater *than five or six weeks trade of the Schuylkill Navigation.*

The *Great Western* road has cost some $32,000,000. The net tonnage upon this line is still less than that upon the London and Birmingham. It does not reach 120,000 through tons per annum.

But the traffic upon these works, light as the tonnage is, has been sufficient, at the high velocity permitted, to produce great destruction.

The former commenced with two tracks of edge rail of 50 lbs. per yard, and wore much of it out before the line was finished.

The latter commenced with a 44 lb. bar between London and Maidenhead, and had rendered it unfit for safe service nearly a year ago. The still heavier iron which they are now using is not, of course, yet entirely destroyed. But before this time next year—if my calculations do not fail—I shall produce evidence in this Journal, that a

portion of these 75 lbs. bars, has also given way under less than 500,000 tons net.

At present, however, we will confine ourselves to past experience, and endeavor to ascertain from *that*, what sort of expectations we have a right to entertain for the future. The new English roads have added but little to our previous information on this head; but still we are not without a great deal of valuable experience; and it is the duty of those who seek for truth, and who seek to exhibit it to others, to profit by the best experience they can find.

In reference to the subject before us, we know,

1st. That some eight or ten of the rail roads of this country, have worn out the common half inch flat bar, with an average aggregate trade of 150,000 tons net, drawn by locomotive engines.

2d. The Camden and Amboy road has, in places, worn out an edge rail weighing about 40 lbs. per yard, with a trade considerably less than 400,000 tons net.

3d. The edge rail on the Columbia road, weighing 33 lbs. per yard, has not yet borne the passage of 350,000 tons on one track, and is nearly destroyed.

4th. On the Boston and Lowell road, a 36 lb. rail was so much injured, or so much weakened, as to need renewing and replacing before it had sustained the passage of 600,000 tons net.

5th. The Liverpool and Manchester road was opened in 1830. In 1835, the *first two tracks of edge rails*, weighing 35 lbs. per yard, were destroyed and renewed; and the trade was less than 600,000 tons net, on each track.

6th. In 1835, the Liverpool and Manchester Company relaid the portion of their road next to Liverpool with edge rails, weighing 50 lbs. per yard—or just five pounds per yard heavier than those of the Reading rail road. Before the close of 1840, these *new rails* (weighing, I say, 50 lbs. per yard,) were worn out, and taken up, and substituted by two other tracks of iron, weighing 64 lbs. per yard. These 50 lb. per yard rails were destroyed by about 700,000 tons net on each track. So that, in the brief space of nine years, this Company destroyed four successive single tracks of edge rails with an average net trade of about 300,000 tons per annum.

7th. The 64 lb. rails next introduced on this road, were found to be *too light*, and a 75 lb. pattern was substituted, which is now the adopted weight. These rails of 75 lbs. have already begun to give way at unsound places—the injury "showing itself chiefly in lamination and occasional splitting at the edges."

8th. The Stockton and Darlington road, considered as a single track, has been *ironed* with edge rails from six to eight times.

Business commenced on this line about the year 1825. In the year 1834, the trade had reached 338,248 tons. In 1840, it had attained the extraordinary limit of 803,784 tons, and up to the year 1842, there had passed along the work a net weight of nearly 6,500,000 tons. At that time six tracks had been destroyed and taken up and replaced, besides the rails that each time were introduced, before an entire change of form was resolved on. How many tracks this patching

may have amounted to, it is probably impossible now to ascertain. *The cars on this road are very light, and the velocity but six miles per hour.*

It is probable that each track of this road has sustained nearly 1,000,000 tons; and with such cars, and at such a moderate speed, it is not improbable that a 50 lb. bar would sustain from 1,200,000 to 1,500,000 tons.

9th. The London and Birmingham 50 lb. iron which was destroyed before the work was finished, sustained about 350,000 tons, on each track. The velocity here was, however, exceedingly great, and the cars unusually heavy.

10th. The net tonnage on the Great Western road, which destroyed the 44 lb. iron, did not reach 300,000 tons of freight and passengers per track. The engines and cars are still heavier than those of the London and Birmingham road, and the average speed 25 miles per hour.

Now, these are facts; and this, whatever it is worth, is *experience.* The intelligent reader must judge from the facts, whether or not, the cost of renewing iron ought to be regarded as one of the current expenses, or as a thing so extraordinary as to require to be excluded from the annual charges altogether, and added, as is now the universal custom, from year to year, to the cost of the road.

But the rapid destruction of iron under the action of a heavy trade, and the measure which, in the December number, I have assigned to its durability on the Reading road, where the velocity is from ten to fifteen miles per hour, is now but faintly denied; or, if denied at all, only by inexperienced parties, and in anonymous communications.

A new view is accordingly taken of the subject, and the important question arises to determine the amount of loss to the company consequent on the destruction of the iron. I mean to offer no conjectures on this head either, but refer to known and admitted facts, as a guide to my conclusions.

I find in the last report of the Boston and Lowell rail road company—the only company in this country, which has renewed a considerable portion of a track of edge rails in one year, and published the cost,—the following charge:

"For labor and sundry materials, in taking up twenty miles of track laid with 36 lb. rails, and replacing it by rails of 56 lbs. per yard, exclusive of the cost of rail iron, $34,162 09." The year before the expenditure for this object was $14,608, so that for changing 25¾ miles of edge rail, the company incurred an expense of $48,770, or $1,900 per mile.

There are seventy-one tons of rails in a mile of the track of the Reading rail road, and the cost of taking up the old iron and putting down new, is, therefore, $1900 for 71 tons = per ton, $ 26.75

A ton of new iron delivered in Philadelphia, will cost, under the present tariff, $60.00

The old iron is supposed to be worth, along the line, per ton, about 25.00

Difference between the value of new iron in Philadelphia and old iron on the ground, per ton,		$ 35.00

The cost of changing the iron track of the road will then be as follows:

Seventy-one tons of iron, taken up and put down, at	$ 26.75	$ 1900
Difference between seventy-one tons of new iron bought, at $ 60,	$ 4260	2485
And seventy-one tons of old iron sold at $ 25	1775	
Seventy-one tons of new iron transported to, and distributed along the line, at $ 5		355
Cost per mile of changing iron,		$ 4740

This sum of $4740 will be the amount due to the trade which will destroy the iron, or render it unfit for safe usage. I know of no iron which has yet withstood the action of a million tons; and I know of no iron of 50 lbs. or less, that is likely to resist that weight. If we consider the rails of the Reading Road to be capable of that effort, then we shall have 4¼ mills per ton per mile for the value of the iron destroyed by each ton of coal descending the line—or 44½ cents per ton for the whole distance of 94 miles. By adopting the rates of speed of the Stockton and Darlington Road, it is probable that the cost of the iron could be brought down to 50 cents per ton, or near that limit; but if the company adopt the heavy cars, (7½ tons when loaded) and powerful engines, and heavy trains now contemplated, and continue the high velocity now permitted, the destruction of iron will probably be scarcely compensated for by seventy-five cents per ton. This is a calculation from such data as we are able to obtain. But was there ever a calculation of such work, which was not exceeded by the practical result? One of the data assumes that there will be as many tons of iron to sell, as were originally bought. But the weight will not hold out. It is useless to inquire why; yet we cannot spread 70,000 bars of iron along a road 100 miles in length, and beat them and roll them for one or two years, and then collect it all again. This is a practical difficulty which must always be encountered under such circumstance. The calculation assumes that it will all be collected; and, besides, that the 140,000 bolts, and the 70,000 chairs to be distributed and replaced, can likewise be found again.

Many visionary estimates have been made on this head, by parties of little experience in the handling of heavy materials, and in the performance of mechanical work; but the following practical facts are a great deal more forcible, and will be found to furnish data which can be applied with much more certainty than any speculative estimate whatever.

The *South Carolina* rail road was opened in the year 1833; the trade averages about 25,000 tons. In the semi-annual report for December 31st, 1838, five years after the completion of the work, we find the following:—"deduct the following expenditures, as being rather for permanent improvement than current expenses, viz:

Machinery,	$ 26,888 12
Spikes,	4,582 34
New rail iron,	3,940 00 &c.

This hint, to the experienced reader, is symptomatic of the contents of the next report, (June 30th, 1839,) from which I extract the following:

"Amount paid for rail iron in Charleston,	$371,679 12	
Less old iron sold and unsold,	92,902 27	
		$278,776 85
Cost of transportation of the same on the road, and laying down, including spikes,		74,400 00
Net cost of new iron,		$353,176 85

Here we perceive that the entire sales of the old iron (when it was all disposed of, it yielded precisely $92,325 71,) exceeded the cost of putting the new rail in the track, but by some $18,000, while the net cost of the new iron, after deducting the proceeds of sales was $353,176. Such is in fact what is to be expected. The old iron will barely pay for putting down the new, and the loss to the company will be about equal to the cost of the new iron delivered at the sea-port.

A writer in the Railroad Journal proposes a scheme for the Reading rail road company *to make money*, by procuring rails free of duty, and selling the old material, after it has been worn out, with the advantages of the duty.

The operation was conducted under precisely those circumstances on the South Carolina road; but the above balance will show that the speculation did not turn out so well in that case. Indeed I have known many instances in which the iron has been renewed, but I have never heard of a company, here or abroad, that found the speculation a profitable one.

In the accounts of the South Carolina road, the new iron is charged to "permanent improvements," (the old iron lasted *five* years,) and the company recommenced with augmented capital.

I have but one word to add in reference to the durability of iron rails subjected to the action of a trade like that of the Schuylkill. I have already stated that if the Reading rail road company expect to obtain the whole trade of the canal, they must prepare for the entire renewal of a single track every year; and I now add, *if the company carry* 500,000 *tons of coal during the present year*, as they now propose to do, the new iron cannot be put down, before that now on the track will be so nearly destroyed as to be unsafe.

It is understood that this company has recently obtained an additional loan of $1,000,000. With this it is proposed to stock and equip the line, and procure the additional track, and prepare for the conveyance of the whole trade of the Schuylkill.

I therefore advance this additional proposition. After this money is expended, and the company shall have put themselves, by its aid, in the position which they seek to occupy, they will neither, in the first place, be able to carry more than *half the tonnage* of the Schuylkill, and, in the second place, if they succeed in obtaining half the tonnage, they will not be able to engage vigorously in the business of 1845, without a *new loan* of a million of dollars; and, finally, if they continue to operate through the present and the next year, they can-

not engage in the business of 1846, without another loan of at least one million. In short, it is *impossible for them to carry the Schuylkill coal trade, without borrowing one million of dollars per annum.* And when they cease borrowing they must cease carrying. I now dismiss the consideration of a road, which, in my opinion, was most unwisely commenced—which has been prosecuted in folly, and which can only terminate in disaster. On this result I desire to rest my claim to the public confidence.

Additional application of the formula.—In the November number of the Journal, I offered a formula for the computation of the annual expenses of lines of rail way, and exhibited its application and agreement with the actual results on seventeen of the most important roads in the country.

The greatest deviation of that formula from the actual result was 12 per cent., which occurred in the case of the Baltimore and Ohio rail road for the year 1841.

In speaking of the deviations, I added these words: "It will probably be seen, on some future occasion, that those roads which now exhibit expenses above the formula, will fall below it for other years; a remark which is applicable *to the Boston and Lowell, Baltimore and Ohio, and South Carolina roads.*" Since the publication of that article, I have received through the politeness of Mr. Latrobe, the able engineer of the Baltimore and Ohio rail road, the report of the operations on that work, for the year 1843, together with some valuable manuscript details, of which I hope to make useful application in the further prosecution of my present study. I am also indebted to Charles S. Storrow, Esq., the valuable superintendent of the Boston and Lowell road, for similar statistics in relation to the excellent, and I believe, prosperous work under his charge, in anticipation of the publication of the report. I have also received from Mr. Storrow, similar information relating to his line, for the year 1841, which I had not before obtained, and from the report of the Baltimore and Ohio rail road company, I find the facts necessary for the application of the formula also to the Baltimore and Washington road for the year 1843.

These results have all been procured since the publication of the formula; and I therefore proceed to test it by making the application to those lines.

It will be recollected that I offered, in the first place, a formula for the determination of the expenses for a *new line*, viz:

$$\frac{24N}{100} + \frac{9T}{1000} + \frac{7P}{1000} + 300\,h.$$

And in the second place, a rule for the computation of the expenses of maintaining an old road, or road which had been opened more than four years, viz:

$$\frac{27.5N}{100} + \frac{14T}{1000} + \frac{7P}{1000} + 500\,h.$$

In both expressions N stands for the number of miles run by the locomotive engines; T for the *tons net* conveyed one mile; P for the

number of passengers conveyed one mile, and h for the length of the road, in miles.

In applying the formula to the Baltimore and Ohio road, it is to be borne in mind, that of the 178 miles in use for the year 1843, but 82 miles were opened previous to 1842, and that the whole of the remaining 96 miles is *new road.*

The result of the application to these several lines is exhibited in the three following tables:

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Bost'n & Lowell,	1841	26	10	125,296	90,113	170,057	$119,469	$111,207	
Bost'n & Lowell,	1842	26	10	143,607	93,927	179,819	131,012	119,409	
Bost'n & Lowell,	1843	26	10	134,982	114,711	176,537	109,367	124,004	
Aggregate for these three years,				403,285	298,751	526,413	359,848	354,620	—1¼

It will be recollected that I anticipated, in the November number, that subsequent results would be more favorable to the Boston and Lowell Road, than that of 1842. We here find it so. In 1842, the formula fell $11,603, or nine per cent. *below* the actual expenses. In 1843 the calculated expenses rise $14,637 *above* the actual expenses. But my remark in the December number should be recollected in these comparisons:—"The formula exhibits what it was intended to show—the average for a number of years." And hence, we have another test. The aggregate expenses on the Boston and Lowell Road for three years are, as we observe by the table, $359,848. The calculated expenses $354,620. This is surely close enough.

Again, we will take the Baltimore and Ohio Road, for the year 1843, for the purpose of an additional application.

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Balt. and Ohio,	1841	82	82½	299,617	44,477	34,580	$220,135	$192,925	
Balt. and Ohio,	1843	178	82½	509,765	39,519	33,670	287,153	322,075	
Aggregate expenses for two years,							507,288	515,000	1½

I have taken no notice of operations on this work for the year 1842,

because during that year the line was opened, in parts, from Harper's Ferry to Cumberland.

The application for the year 1841, gave a result of $27,210 *below* the actual expenses. I stated at the time that the subsequent expenses would be likely to fall *below* the calculated expenses. We accordingly find the result for the next year comes $34,000 below the formula. Here, then, is another, and most conclusive, confirmation of the correctness of the formula, and of the principles on which it is founded. If we take the *sum* of the expenses for the two years, we find the calculation $515,000, and the *fact* $507,288.

But we have yet a third case: the Baltimore and Ohio Railroad report for 1843, exhibits, as has been stated, the results on the Baltimore and Washington Road, likewise for that year. These, together with those of 1841 and 1842, are presented in the following

TABLE.

Name of Road.	Year.	Length in miles.	Gr'de in feet.	Miles run.	Thro'h tonnae.	Thro'h travel.	Actual expenses.	Calculat'd expenses.	Error pr. cent.
Balt. & Wash.	1841-2	30½		91,428	27,369	114,260	$ 73,684	76,166	
Balt. & Wash.	1843	30½		96,716	26,470	86,880	68,866	71,676	4

Here is an agreement within 4 per cent.

When I presented this formula in the November number of the Journal, and exhibited its application to seventeen lines of railway, I stated that these seventeen lines *were all the roads for which I had been able to collect the statistical information necessary for the application*. I had written to many companies, and had generally been supplied with the facts required, and which were not given in their reports. In some instances, however, they were unable to furnish the information which I needed; in two instances I received no reply to my letter; and in one—and I am happy to say one instance *only*—the officer declined making the affairs of the company public.

Since then the three companies above named have published their reports; and *they are the only reports for the year* 1843, which I have yet received. These reports add confirmation to the previous proof. Still, I advance the formula as an approximation only, which I hope, with the aid of my professional friends, and future facts, so to modify and improve, as to render its application general and certain. It is the expression of the true LAW; but the *constants* are to be built up by multiplied facts, until there can no longer be room to doubt its indications.

I have endeavored, so far, to conform to the method which modern science points out as proper to be pursued in practical inquiries. Much injury has been inflicted on the great cause of internal improvement, and especially of railroad improvement, by the erroneous opinions of enthusiastic, but unwise, advocates. But a new order of things has grown up, and a new system of enquiry is rapidly

gaining ground. The seed of true principles have been sown, and the roots have struck deep into the soil of this country. Under the control of these principles, and the direction of cool and honest advocates, the railroad cause will take fresh growth, and flourish with a vigor and heathfulness which it has not yet exhibited. Some visionary and extravagant projects, which are now bearing heavy upon it, will sink under the pressure of their own weight, and serve, even in their ruins, as salutary guides for the future.

During the transition, TRUTH will be for a time obscured, and possibly borne down; but it cannot be overcome. It is sustained by a power which is invincible. Truth makes no compromise of principle—yields nothing for the sake of present popularity—contributes nothing to the cause of public deception—and moves fearlessly, surely, and, in the end, all powerfully, to its mark.

[NOTE.—In the January number of the Journal, I offered an estimate of the probable expenses on the Reading Railroad for the year 1843, in anticipation of the publication of any facts on that subject—assuming the travel at 40,000 passengers, and the trade at 250,000 tons. This estimate was $265,000. I regret to find, on perusing the last report, that the company have not thought it expedient to publish their expenses for the *whole year;* but have preferred to exclude the last month, along with the heavy bills which the close of the year usually brings with it. The expenses published, for eleven months, amount to $221,060 89. I should have been exceedingly gratified to know the amount of expenses for the whole year.

The indebtedness of the company since the date of the previous report of January 1, 1843, has been increased, $ 1,252,659

The receipts for the first eleven months of the year, amount to 385,195

Aggregate expenditure for eleven months, $ 1,637,854

A statement of the *items* which have consumed this enormous sum would certainly be read with interest and instruction; and it is greatly to be regretted, that at this particular period, when the public are exceedingly anxious for truth and information, the directors have deemed it imprudent to publish it.]

NOTE.—The writer has expressed his opinions on an important subject without reserve, or concealment; should his *facts* be publicly disputed, or conflicting facts be presented, by any of his professional brethren, he trusts that they will have the consideration to do it over their own signatures—that he may have the guarantee of a name for the facts which *they* contribute. He will be found as frank in correcting his errors, if he has committed any, as he is sincere in the expression of his opinions.

To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Herron's Trellis Railway Superstructure.

For the information of such of our readers as feel interested in the details of railway construction, we give room below for two documents relating to the experiment made with Herron's Trellis Superstructure, upon the Baltimore and Susquehanna Railway, in the suburbs of Baltimore. The length of the trellis track is about one-eighth of a mile; it lies partly upon an embankment, and partly in a sidehill cut; it is curved horizontally upon radii of 477, and 716 feet, with a short tangent between the curves, whilst its profile shows a grade of 84 feet to the mile.

Document No. I, consists of a letter addressed by Charles Howard, President of the Baltimore and Susquehanna Railroad Company, to James Herron, Civil Engineer, the portion in brackets being added by the latter. Document No. II, is a letter addressed to the President above mentioned, by D. C. H. Bordley, Superintendent of the road.

COM. PUB.

No. I.

In reply to your favor of the 11th inst., I take pleasure in handing you the enclosed report from Mr. Bordley, the Superintendent of our road, to whom I referred your letter. His statements of any facts may be implicitly relied on. The present condition of your track speaks for itself; and it may, at any time, be examined by any person who will take the trouble to visit the depot.

Coinciding as I do entirely in the opinions expressed by Mr. Bordley, it is unnecessary for me to reply to your questions. To do so would be merely to repeat what he has said; and I therefore refer you to his answers, as being those which I should give. For the information of those who are not informed of the circumstances, I will, however, explain how it is that we have not had an opportunity of subjecting your track to the test of bearing the daily passage of locomotives at high rates of speed. The track laid by us under your directions, and according to your plan of construction, is 672 feet in length, in the vicinity of our principal tonnage depot, to and from which locomotives occasionally pass with their trains; but the cars are most generally taken over this part of our track by horse power. On the other hand, the whole of your track is laid in a short curve, and has, of course, been much more liable to be thrown out of adjustment than if in a straight line, or curve of greater radius. [The curvature is in part 12° deflection to a 100 feet, and in part 8° to a 100 feet; the grade is also 84 feet to the mile. So that scientific engineers may judge of the severity of the test to which this track has been subjected from the centrifugal force of the trains, which are usually checked upon this steep gradient, by the brakes, and carried down to the depot in detachments. It is also worthy of remark, that contracted as is the curvature, and steep the grade, the engines and cars have never yet ran off of it. As a test of stability it has certainly been subjected to much rougher usage in its present position than it would have suffered on any other part of the road; of which any one

would be convinced by observing the straining of the horses, and surging of the engines, in dragging the heavily loaded cars up this steep grade, and through so contracted a curve.]

The cost of repairs generally includes that of the labor required in consequence of the subsidence and washing of new embankments, of the filling up of drains, &c., as well as that employed in adjusting the track. I cannot, therefore, say what is the cost solely of keeping an ordinary track in proper adjustment, independent of the other items; neither would our experience authorize me to assert that a track constructed upon your plan, would require no expense to keep it in adjustment where heavy locomotives, with large trains, might be daily passing over it with ordinary velocity; but I am convinced that it would cost less by fifty dollars per mile per annum, to keep such a track in order, than one of any other description with which I am acquainted, and the difference might be still greater. [The repairs on the road last year averaged two hundred and twelve dollars per mile, and as the repairs of the embankment, &c., of the trellis track has averaged only four dollars per mile for more than three years, it follows that the actual saving was at the rate of two hundred and eight dollars per mile per annum. But allowing fifty dollars per mile for clearing ditches, and repairs of embankments, which Mr. Howard, in a subsequent conversation, admits to be more than sufficient for these objects; or with incidental repairs to a trellis track, say sixty-two dollars per mile, it follows that if the whole road were laid with a trellis track of kyanized timber, there would result a saving to the company, on the repairs of the track, of one hundred and fifty dollars per mile; and action and reaction being equal, a similar saving would be effected in the wear of machinery, making the sum saved three hundred dollars per mile; which, on seventy miles, is twenty-one thousand dollars per annum, a sum which is equal to six per cent. on three hundred and fifty thousand dollars, exclusive of the saving in increase of traction, from the evenness of the track, and the increased comfort in traveling.]

It is unnecessary for me to do more than allude to the advantage which the continuous bearing of the rail gives to your track, over one in which no string pieces are used. The saving made by the former in the wear and tear of machinery, and in the power required to draw a given load is considerable.

In conclusion, I have no hesitation in expressing the opinion, that if the wood work be protected from decay, a track laid on your plan would be decidedly superior to any other of which I have any knowledge.

Office of the Balt. & Susq. R. R. Co.,
Baltimore, December 15th, 1843.

No. II.

The following are answers to Mr. Herron's questions:

1st. Herron's railway track has been laid on the Baltimore and Susquehanna Railroad three years and two months, (since October, 1840.)

2nd. Its condition is good; I can see no alteration since it was "first finished," except over a culvert that was newly built and filled over about the time the track was laid; this was raised once at a cost perhaps of *one dollar and fifty cents*, and it is at this time slightly sunken.

3rd. I do not think a track of ordinary construction would have retained its curvature and evenness of surface under the same circumstances.

4th. None of the iron fastenings have been removed, driven, or adjusted since it was first laid.

5th. The wrought iron chairs at the joints of the rails have held the ends of the bars securely, joined them evenly, and allowed the bars to contract and expand. I think them an improvement on the common chairs.

6th. I have observed no endwise movement of the rails upon the track.

7th. The track has required *no* adjustment, or raising, except as above mentioned, in answer to question 2nd.

8th. There has been no spreading of the track; the rails have maintained a regular parallelism, and also the degree of curvature first given to them.

9th. The track has been found equally adapted to horse power, and locomotive engines. I do not perceive that it possesses any material advantage over a track laid in the usual way, as regards the horse path; the trellis pieces being sawed to an even thickness, the track will require less filling to afford an even surface.

10th. I do not consider the covering of the trellis work, by the ballasting, sufficient to preserve the timber from decay materially; but it adds to the stability of the track *very much*, and will preserve it from fire.

12th. It is my opinion that a road constructed on the trellis plan of *kyanized timber*, would be a very durable structure, and would require but little expensive repairs for a number of years; but whenever it had to be renewed, or repaired extensively, would be found more expensive than one laid in the usual way.

13th. From the opportunity I have had of observing the working of the trellis track, I do, upon the whole, consider it greatly superior to the railway tracks in general use, at least, a great majority of them; I would be reluctant to pronounce it superior to *any other*, unless I could first see it tested by running locomotives on it at the usual speed; from the position of this track it has never been possible to do it. I have no reason to think, however, that the trellis track would, under any circumstances, prove *inferior to any track*, until a renewal of timber was found necessary; and this would be at very long intervals, if it was kyanized.

I have not attempted to answer the 11th question, (relative to the comparative expense of the trellis, and other railway superstructures) because I have no knowledge of what the construction of the track cost on this road, nor have I a knowledge of the cost of tracks on any other roads, by which I could make a comparison.

I am very favorably inclined to Mr. Herron's track; the excellence of its surface, both *winter* and summer, speaks much in its praise, and I feel sure that a road made on his plan would prove smooth and pleasant, and would *save* in the item of "*wear and tear of machinery.*"

Belvidere Depot, December 11th, 1843.

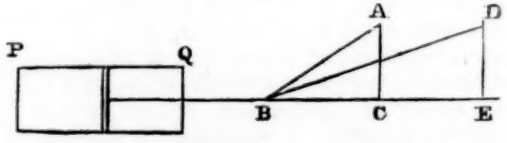
The relative efficiency of Long and Short Connecting Rods, considered in the exposition of crank and connecting rod motion. By H. F. CLIFFORD.

The subject of the following paper is one of great importance to the practical mechanic; and as we have never yet seen any satisfactory solution of this long disputed question, we have endeavored to draw such conclusions from the investigation of the theory of crank and connecting rod motion as we feel convinced will set at rest all previous doubts concerning the comparative advantages of long and short connecting rods. With a given force in the direction of the piston, our object in the present investigation is to ascertain the best means of obtaining the greatest amount of that force in the direction of rotation, and thus render friction as small as possible; in other words, whether is a short or long connecting rod the more effectual method for fulfilling the conditions of our proposed inquiry?

We shall first show that if F be the original force exerted by the piston rod of a steam engine along its own axis, that there is more of that force transmitted in *the direction* of the long rod than the short one.

Let P Q, Fig. 1, be a cylinder with piston, and let the piston rod exert a force F, at the point B, where the rods B A, B D, connect it respectively to the cranks A C, D E.

Fig. 1.



Let A B make an angle (ϕ) with the horizon.

B D — (θ) —

The resolved part of F $\begin{cases} \text{in the direction of A B} = F \cos \phi. \\ \text{— B D} = F \cos \theta. \end{cases}$

Now the magnitude of the force in either direction depends on the cosines of the angles, which the respective rods A B. B D, make with the horizon, and since $\cos \phi$ and $\cos \theta$ become a maximum when ϕ and $\theta = o$. it follows the smaller the angle the larger the numerical value of the cosine, and since θ is considerably less than ϕ, the long rod has evidently more of the resolved part of F in its direction than the short one.

Again—

The resolved part of F $\begin{cases} \text{in the direction of A C} = F \sin \phi. \\ \text{—} \qquad\qquad \text{D E} = F \sin \theta. \end{cases}$

The magnitude of the forces in this case depends upon the sines of the angles, and since the larger the angle the greater the sine, the resolved part of F in A C, is much greater than that in D E; in other words, the pressure into the centre, or friction in the axle, is more in the short than in the long rod.

Having proved then that there is more force in the *direction* of the long rod, we now proceed to show that *the resolved part of the force in* B A, and B D, *in the* DIRECTION OF ROTATION, is greater in the case of the long than the short rod; or,

Proposition. To find the part of the force exerted by the piston rod of a steam engine which is perpendicular to the crank, in any given position of the fly.

Let E A, Fig. 2, be the piston rod, the direction of which produced is supposed to pass through the centre of the fly C; A B, the connecting rod; C B, the crank; B T D, the tangent at B.

Let C B $= a$, A B $= b$, A C B $= \theta$, B D $= x$, A D $= z$.

$\angle$ A C D $= \phi$, $\angle$ the tangent makes with the connecting rod A B.

The resolved part of F in B A $=$ F cos B A C.

$$= F \cos (A\ D\ B + A\ B\ D.)$$

$$= F \cos \left(\phi + \frac{\pi}{2} - \theta\right)$$

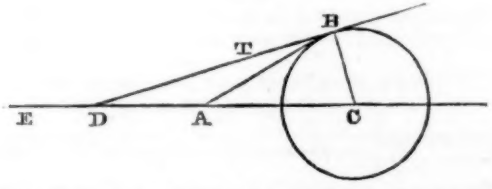
$$= F \sin (\theta - \phi)$$

$$= f \text{ suppose.}$$

The resolved part of F in B D $= f \cos \phi$.

$$= F \cos \phi \sin (\theta - \phi) \qquad A^*$$

Fig. 2.



* The solution of this equation is rather intricate, as we have to express the value of F in B D, in terms of the known quantities θ, a, and b; but, as it is desirable to know the result, we give the working.

$$\text{Now } \cos \phi = \frac{b^2 + x^2 - z^2}{2bx}$$

$$x = \text{B D} = \text{B C} \tan \theta = a \tan \theta.$$

$$\frac{z}{\text{A B}} = \frac{\sin \phi}{\sin \text{A D B}} = \frac{\sin \phi}{\sin\left(\frac{\pi}{2} - \theta\right)} = \frac{\sin \phi}{\cos \theta}.$$

$$\therefore z = b \frac{\sin \phi}{\cos \theta} = b \text{ sin. } \phi \text{ sec. } \theta$$

By substitution in equation 1, we have

In investigating equation A, it is evident that the smaller the angle ϕ the greater the force in B D, and the longer the rod A B, the smaller the angle it makes with the tangent, and thus we have more of the resolved part of the force in B A, in the direction of rotation in the long rod, *à fortiori*, how much more have we of the original force F, transmitted by the piston in the direction of rotation in the case of the long than the short rod.

There is, however, a small arc in the crank's orbit, in which the

Fig. 3.

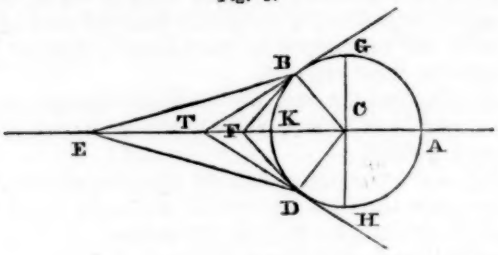
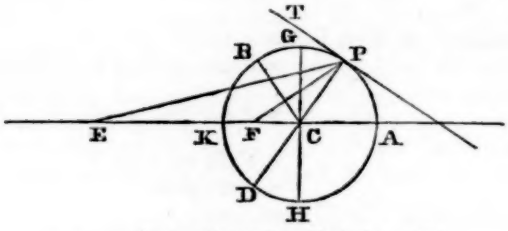


Fig. 4.



$$\text{Cos. } \phi = \frac{b^2 + a^2 \tan.^2 \theta - b^2 \sin.^2 \phi \sec.^2 \theta.}{2ab \tan. \theta}$$

$\therefore 2ab \tan. \theta \cos. \phi = b^2 + a^2 \tan.^2 \theta - b^2 \sec.^2 \theta (1 - \cos.^2 \phi.)$

$\therefore b^2 \cos.^2 \phi \sec.^2 \theta - 2ab \tan. \theta \cos. \phi = (b^2 - a^2) \tan.^2 \theta.$

Dividing by $b^2 \sec.^2 \theta$ and putting $\frac{a}{b} = 2m$, we have

$$\text{Cos.}^2 \phi - 2m \sin. 2\theta \cos. \phi = (1 - 4m^2) \sin.^2 \theta$$

Completing the quadratic and extracting the root $\Big\}$ $\cos. \phi - m \sin. 2\theta = \times \sin \theta \sqrt{1 - 4m^2 \sin.^2 \theta}.$

Now the positive sign must be taken in order that cos. ϕ may be always possible.

$$\therefore \text{Cos. } \phi = m \sin. 2\theta + \sin. \theta \sqrt{1 - 4m^2 \sin.^2 \theta},$$

$$\text{And sin. } \phi = \sqrt{\cos.^2 \theta - 4m \sin.^2 \theta (m \cos. 2\theta + \cos. \theta)} \sqrt{1 - 4m^2 \sin.^2 \theta}.$$

Let X = the resolved part of f, in B E,

then from equation A, X = F cos ϕ sin. $(\theta - \phi.)$

$$= \text{F sin. } \theta \cos.^2 \phi - \text{F cos. } \theta \sin. \phi \cos. \phi.$$

Putting for sin. ϕ and cos. ϕ their respective values, $X = \text{F sin. } 3\theta \Big\{ 1 + 4m$

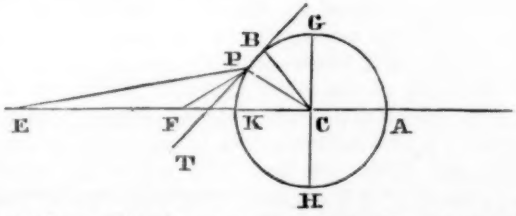
$$(m \cos. 2\theta + \cos. \theta \sqrt{1 - 4m^2 \sin.^2 \theta}) \Big\} - \text{F cos. } \theta \sin. \theta (2m \cos. \theta +$$

$$\sqrt{1 - 4m^2 \sin.^2 \theta}) \sqrt{\cos.^2 \theta - 4m \sin.^2 \theta (m \cos. 2\theta + \cos. \theta \sqrt{1 - 4m^2 \sin.^2 \theta}},$$

which is the required equation.

short rod possesses an advantage, for let E B, F B, be respectively a long and short connecting rod, A G H, the fly G C H, perpendicular to A E, and let the crank (in Fig. 3) be in such a position that B T, the tangent, bisects the ∠ between the rods; let D be the point corresponding to B on the other side of E A, then the points B D, will evidently lie between G and K, and R and H. Let C P (in Figs. 4 & 5) represent the other position of the crank, and let P T be the tangent at P. First suppose the forces exerted by the connecting rods in their *own directions* to be equal, then it is clear (in Fig. 3) their resolved parts in the tangent will be equal, since ∠ E B T = ∠ F B T. Now from Fig. 5, it will be seen, that while the crank moves from B to K and from K to D, the short rod makes a smaller angle with the tangent than the long one, consequently, through this arc, the short one possesses an advantage; but, on the other hand, in Fig. 4, while the crank moves from A to B, and by parity of reasoning, from D to A, the long connecting rod makes the smaller angle. Hence, if we suppose the forces exerted by the rods in their own directions to be equal, the long rod is preferable, since in a whole revolution of the crank, it has the advantage through the arc D A B, which is > arc B K D, through which the shorter one has the advantage. But the forces exerted by the rods in their own directions are not equal, since if F be the force exerted by the piston F cos P E F, the force in the direction of the long rod is always greater than F cos P F C, the force in the direction of the shorter one, except when P coincides with A or K, when they are equal, and thus the superiority of the long rod in the entire orbit in *the transmission of rotary force*, has been satisfactorily demonstrated. Lastly, since the resolved part which produces rotation is greater in the long than the short rod, the resolved part perpendicular to this direction, or tending to the centre of the fly, is less in the long than the short rod; and this resolved part produces friction on the axis of the fly, which is the chief thing to be guarded against.

Fig. 5.



It is this trifling advantage possessed by the short rod that has induced several clever practical mechanics, with whom we are acquainted, to argue in favor of its superiority; but, whilst we agree with them, that it has the property of pressing at a more favorable angle during the progress of the crank through a very small arc, they must not forget the gradual increase and decrease of the force exerted by the piston on either side of the dead power point R, the*

* The circumstance of the piston's motion not being uniform is also in our favor, since the force exerted varies from zero to a maximum, as the piston travels from K to G and from K to H; and whilst this fact renders the advantage spoken of still more trifling, we have the long rod exercising the superiority at a time when the piston's exertion is a maximum.

inequality of the forces in their own directions, and that, moreover, this alleged superiority lasts only during a very limited portion of the crank's entire revolution.

Theoretically speaking then, there is no limit to the length of the connecting rod of a steam engine, but in practice, we are generally confined for space in the erection of machinery; still from the preceding analysis, we should endeavor to make it as long as we conveniently can, in order to obtain the greatest amount of rotary force, and thus render friction as little as possible. This subject might be practically illustrated, by taking a steam cylinder, furnished with the usual appendages, and connecting the piston rod end to the crank with a rod fitted with a long eye, or slot, so that the length of the rod could be adjusted at pleasure. On the crank shaft put a small drum, and suspend a heavy weight, that has to be wound up over it. By comparing the work done in a given time with the same amount of steam from the boiler, (at an equal pressure in either case,) it will be found that the result of the experiment, if accurately performed, will fully attest the superiority of the long rod, as shown in our theoretical deductions.

Civ. Eng. & Arch. Journ.

The Screw Propeller—Smith's Patent.

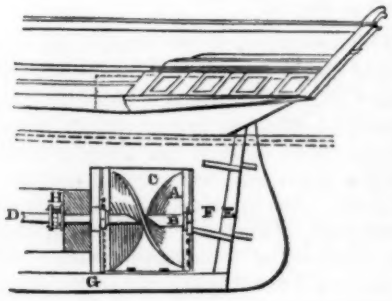
The complete success which has attended the application of the screw for the propulsion of vessels by steam, in every instance, induces us this week to lay before our readers some particulars connected therewith, and the performances of some of the ships which have during the past four years been fitted with it. Hitherto the vessels to which the screw has been applied have been of moderate tonnage, and it became a question, much canvassed among nautical and scientific men, whether it would have sufficient power to answer the expectations of the inventor in ships of extraordinary size and burthen; but the trial trip of the *Great Northern* down the river, on the 11th inst., when she accomplished ten and a half miles per hour without using any sails, has completely set the matter at rest, and proved the efficiency of the screw propeller for vessels of every size and description—and it is remarkable, that, although the propeller that has been applied to this monster ship is smaller in proportion to her tonnage than any other that has been yet fitted, her rate of speed under steam has surpassed the most sanguine expectations of all who have witnessed her performances.

The screw originally introduced into the *Archimedes* (the vessel on which the first really practical trial was made) consisted of one entire turn 8 feet in length and 7 feet in diameter; this, however, being found too large for the steam-power to drive with requisite velocity, was gradually reduced to 5 feet 9 inches—subsequently it was divided into two half turns, which reduced it to half its length, while the superfices of the screw remained the same. Various propellers tried by Mr. Smith in small experimental boats, and subsequently in

the *Archimedes*, have shown that the most effective form is one entire turn of the thread; this, however, for the sake of compactness, may be divided into two half, three thirds, or even four quarter turns, which renders the propeller considerably shorter, while its useful effect is in no way diminished.

The angle which the thread should make with the shaft has been closely experimented on, and it has been found that an inclination varying from sixty to seventy degrees at the circumference has produced the best result. The circumstances, however, which would determine the precise angle between the two, as also its diameter, depend on the form and description of vessel to be propelled—for instance, if a tug or heavily laden vessel, the latter angle would be most suitable; but in a vessel of fine lines and light draught of water, the former would be best adapted in order to obtain a high rate of speed.

On starting the vessel in a dead calm, a column of water in the shape of an inverted cone may be seen thrown astern of the ship, from which it is inferred that the whole force of the screw is propellant in the direct line of its axis, while that of the paddle-wheels is partially lost in entering the water and raising it considerably above the level on leaving it, which produces the swell so much complained of in river steamers. The position of the screw is in the dead wood immediately before the rudder, the keel being continued along underneath it. One great advantage of the screw being placed in this position is, the transferring the whole weight of the propelling apparatus from the top sides of a vessel to the lowest part of the hull; and in the *Great Britain* (of 3600 tons), recently launched at Bristol, it has been ascertained that in applying the screw, instead of paddle-wheels, as originally intended, 100 tons of superabundant weight have been removed from her upper works—a circumstance of immense importance to the safety of the ship when laboring in a heavy sea. The annexed engraving shows more clearly the principle and situation of the screw propeller:—



DESCRIPTION.

A—The thread or worm of the screw.
B—Screw shaft.
C—The opening or space in dead wood.
D—Propeller shaft.
E—Solid stern-post.
F—Dead wood of the vessel.
G—Iron or metal knees, which carry the propeller.
H—Stuffing box, through which the shaft passes to the engine.

As the speed obtained by the Archimedean screw is, perhaps, one of the most important points under consideration, we will now pro-

ceed to give some particulars of the performances of those ships which have already adopted it.

Summary of the Performances of the "Archimedes."

(237 tons, 70-horse power.)

May 14, 1839.—Made the passage from Gravesend to Portsmouth in twenty-one hours, against a strong westerly breeze.

October, 1839.—Beat the Hon. East India Company's steamer *Queen*, of 220-horse power, upwards of three quarters of a mile in a run of eight miles.

April 18, 1840.—She was ordered to Dover for the purpose of trying her powers with her Majesty's packets at that station, on which occasion the fastest of them, the *Widgeon*, was beaten nine minutes between Dover and Calais, and five minutes on the return trip, which was done in one hour and fifty-three minutes—being the quickest passage ever made between England and France, by fourteen minutes. The Dover boats vary from 70 to 90 tons less, their engines from 5-horse to 10-horse power more, and the draught of water from four to five feet less than the *Archimedes*.

June 5.—Ran from Milford to Liverpool (200 miles) in nineteen and a half hours. Surpassed the swiftest boats on the Mersey; and on one occasion beat to windward up that crowded river with as much facility as an ordinary sailing ship. From Liverpool to the Isle of Man she beat the *Mona's Isle* packet (a vessel of superior power) nearly two hours—running the distance of seventy miles in seven hours and fifteen minutes.

August 1840.—She performed the passage from Plymouth to Oporto in sixty-eight and a half hours, and the homeward trip between those places in eighty-eight hours, with wind a-head nearly the whole distance.

November, 1841.—During her passage from Bristol to London, made headway at the rate of three and a half knots per hour against a tremendous sea, whilst other steamers of much larger power bore up, as shown by the pilot's certificate.

"Princess Royal."

(Steam-tug boat, on the screw principle, 45-horse power.)

After beating the fastest of that class of boats on the Tyne, performed a passage from that river to Brighton in forty-eight and a half hours, a distance of nearly 400 miles. She has towed out of Shoreham Harbor, at one time, two large brigs, against the wind, and tide setting in, at the rate of four miles per hour; on another occasion, towed out a brig, which carried away both topmasts immediately the steamer had cast off. This little vessel, also, went to sea with comparative ease, whilst the *Dart* steamer, of 120-horse power, was more than half an hour before she could accomplish the same object, owing to the sea and tide running at the time.

"The Great Northern."—Extracts from her Log.

Sunday, Dec. 25, 1842.—8h. 5m. Weighed anchor in Cowes Roads, and put the ship on her course for London, under steam and canvass.

9 50 a. m. Massey's log put overboard; revolution per minute of engine, 18; rate per common log, 10 knots; Massey's log, 10¼ do. 11 50 a. m. Stopped engines abreast of the Ower's light-ship, and disconnected the screw; ship put on her course up channel, with sails only. Noon. Fresh breezes and cloudy. 2 30 p. m. Abreast of Beachy Head; ship brought to her course. 5 5 p. m. Massey's log hauled in. (Note—The distance run from the Ower's light-ship, by chart, sixty-six nautical miles, in five hours and two minutes.) Hove to, and fired guns for a pilot. 5 50 p. m. Took pilot on board; wind increasing. 7 50 p. m. Anchored in the Downs in eight fathoms water.

Monday, Dec. 26. —4 a. m. The wind blowing a gale, down royal and top-gallant yards. 8 50. Changed pilots. Noon. Gale increasing, and a great number of ships running for the Downs. Midnight. Weather about the same.

Tuesday, Dec. 27.—9 a. m. Gale suddenly moderated; steam raised to assist in getting the anchor. 11 40 a. m. Got under weigh, and proceeded through the Downs, setting fore and aft sail, wind being directly a-head. 5 17 p. m. Abreast of the Nore light. 9 p. m. Anchored nearly opposite the Chapman beacon.

Wednesday, Dec. 28.—7 a. m. Got under weigh, steaming only; wind a-head. 9 5 a. m. Stopped off Gravesend and changed pilots. 9 17 a. m. Started for London against ebb tide and light wind. 12 a. m. Abreast of Woolwich. 12 20 p. m. Arrived at Blackwall, and moored ship, having stopped six minutes in Longreach to adjust machinery, thus accomplishing the run from Gravesend to Blackwall (twenty-one miles) in two hours and fifty-seven minutes, the mean rate of the tide being taken at two miles per hour.

Since the *Great Northern's* arrival at Blackwall, considerable improvement has been effected in her engines, by Messrs. Miller and Ravenhill, which was satisfactorily shown in her trials on the 11th instant, in the presence of a large party of gentlemen connected with science and the shipping interests. We subjoin the following particulars of her dimensions.—

	Ft.	In.		Ft.	In.
Extreme length	247	0	Diameter of screw	11	0
Extreme breadth	37	0	Length of screw	5	10
Length bet. perpendic.	222	0	Pitch of ditto	14	0
Depth in hold	26	5	Length of mainmast	90	0
Draught of water	18	0	Length of mainyard	79	0
Diameter of cylinders	5	8	Diameter of ditto	1	10½
Length of stroke	4	6	Length of foremast	83	0
Immersed area of mid sec	542	0	Length of mizenmast	61	0
Area of screw propeller	75	0	Spread of canvass	6700 yards.	
Burthen			1515 tons.		

It will be seen from the above extracts from her log, that the *Archimedes*, though not built for extreme speed, but more to show the practicability of uniting sailing and steaming qualities in one vessel, has succeeded in beating many vessels of superior power, built expressly for steaming. Her utmost speed under steam alone was nine

and a quarter knots; with steam and sails combined, under the most favorable circumstances, it was upwards of eleven knots. This is particularly worthy of consideration, as showing the utility of a moderate steam-power on board sailing vessels in case of calms or contrary winds, while the expenditure of fuel need not be resorted to during favorable winds merely for the trifling gain above stated. Upon twenty out of thirty-two points of the compass a ship would be able to dispense with her steam power altogether.

The great superiority of the screw is most apparent in causing the ship immediately to answer her helm; the stream of water thrown astern by its action keeps the helm steadily amidships, and the slightest movement of the wheel is sufficient to govern her. In turning about, the effect of the screw is surprising; on the *Archimedes* putting the tiller hard over, she performs a complete circle in two and a half minutes, and two and three quarter minutes the second—the rudder acting as a drag on the stern, it takes longer time to make a second circle than the first, yet the space occupied is less, until the vessel seems to turn on a pivot—an entirely new manœuvre in navigation.

Lond. Mining Journ.

Historical notices of Screw Propelling.

(Ante) 1727. In the "Machines et Inventions approuvées par l' Academie Royal des Sciences depuis 1727, jusqu' an 1731," there is described a machine by one Duquet, for forcing a vessel *up a river against the current by* MEANS OF THE SCREW.

1768. In a French work by Paucton, on the "Theory of the Screw of Archimedes," the author proposes to substitute for the common oar an instrument which he calls a "*pterophore*," *composed of the circumvolution of the thread of a screw round a cylinder.*

1792. Baron Seguier states that some time before this date, there was to be seen at the Conservatoire des Arts et des Metiers of Paris, the plan of a steamboat which was to be propelled by a *screw fixed in, or connected with, the rudder.* Jobard's Bulletin, 1842.

1802. A propeller was successfully applied by John Shorter, to H. M. S. Doncaster, at Gibraltar, which Mr. Galloway, on the authority of Mr. Napier, states, was on the principle of the screw. Galloway's Appendix to Tredgold, p. 4.

1804. In "Memoire sur les Bateaux á Vapeur des Etats Unis d' Amerique," by Marestier, it is mentioned that a vessel had been propelled, or proposed to be propelled, by means of a "*helicoidal surface*," nearly as long as the vessel, enclosed in a channel running fore and aft.

1816. Mr. Robertson Buchanan in his Treatise on Propelling Vessels by Steam, says, "Experiments have been made on a kind of screw, but this I believe, after a trial on a considerable scale in America, was rejected. Some mechanics, however, still think favorably of it, and suppose that if a screw of only one revolution were used, it

would be better than where a longer thread is employed." The American experiments here alluded to, are, no doubt, those spoken of by Marestier.

1818. About this time an English engineer, of the name of Brain, settled in Belgium, is said to have announced that he had discovered a new means of propelling vessels, namely, "*by screwing them through the water.*" Jobard.

1819. October 1, a Mr. Whytock announced (Edin. Phil. Journal, vol. ii, p. 19,) that he had five or six years before made various experiments in propelling boats by means of two screws; *the lines of which were obtained from the circumvolution of a thread round a cylinder.* The screws would seem to have been applied one on each side of the boat; but Mr. Whytock's description is so worded as to leave this in some doubt.

Mr. Scott, of Ormiston, proposed to employ a screw working in a cylinder entirely immersed in the water. Thompson's Annals, vol. xi, p. 438.

1824. August 9; Mr. Jacob Perkins patented "certain improvements in propelling vessels," which consisted in fixing at the stern two sets of revolving oars, having their centre of rotation *above the water*, and entering it obliquely at the same time on opposite sides of the rudder, and after each revolution leaving the water at the sides opposite to the respective entrances.

1825. Mr. Samuel Brown applied to an experimental boat a propeller on the principle of the screw, consisting of two flat blades affixed to a longitudinal shaft at an angle of 45°, and placed in the *bow* of the boat.

1826. Nov. 18; Mr. Bennet Woodcroft, of Manchester, patented certain "improvements in wheels and paddles for propelling boats," the nature of which improvements is thus described by Mr. Woodcroft in his specification: "I declare that my said invention consists in a *spiral* paddle, made of wood, metal, or any other suitable material of the following construction, by the revolution of which boats, or other vessels may be propelled on water; that is to say, a spiral worm-blade, or screw, coiled round a shaft, or cylinder, of any convenient length and diameter, in such form that the angle of inclination, which the worm makes with the axis of the cylinder, continually decreases, and the pitch, or distance, between the coils, or revolutions of the spiral, continually increases throughout the whole length of the shaft, or cylinder, upon which the spiral is formed, the effect of which construction is as follows: The spiral paddle being made to rotate in the water, when the commencement of the spiral blade, or that part of it which forms the greatest angle with the shaft, acts upon the water, it gives to it an impetus, or motion, towards the back end of the paddle, thus creating a current in the direction of the spiral. If this current were to reach the succeeding, or following, parts of the spiral paddle, before those parts take their action upon the water, such following parts would move in, or keep pace only with the current, and would, therefore, meet little or no resistance from the receding water, and a part, or whole, of their action would

be lost, or without effect; but by previously elongating the pitch of the spiral, each successive part of the spiral begins to act before it is overtaken by the current given to the water by the action of the preceding part of the spiral, and, consequently, every part meets resistance from the water, and thereby gains a proportion of propelling power."

1827. Tredgold, in his work on Steam Navigation, notices several of the preceding plans, and enters into a full investigation of the properties of the screw as a marine propeller.

1828. Dec. 10; Charles Cummerow, of London, merchant, patented "certain improvements in propelling vessels," which he stated were "communicated by a foreigner residing abroad." These improvements consisted in the application of a screw at the stern, *placed in the dead-wood immediately before the keel.*

1829, Nov. 20. American Letters Patent were granted to Benjamin M. Smith, for the application of "sculling wheels, or screw propelling wheels to boats."

1831, April 27. American Letters Patent were granted to Doctor Giraud, for "a screw, or spiral lever, for the propelling of vessels."

1836, May 31. Mr. F. Petit Smith patented "an *improved* propeller," consisting of "a sort of screw, or worm." According to the description given in the specification, and the accompanying drawings of this "sort of screw," it differed in nothing from any other sort of screw; and so far, therefore, as the "propeller" was concerned, no *improvement was shown.* The drawing, however, represents the screw as being placed in a recess cut in the dead-wood immediately before the rudder; and on this peculiarity of position, though both Cummerow and Woodcroft had before proposed the same thing, has been founded a claim to novelty! At first, indeed, the patentee laid no stress whatever on this circumstance, for his original claim was in these words: "I claim, as my invention, the propeller herein-before described, *whether arranged singly in an open space in the dead-wood, or* (in duplicate) *one on each side of the same, or more forward, or more aft, higher up, or lower down, completely, or partially, immersed;*" but afterwards (May 28, 1839,) he entered a Memorandum of Alteration, in which he represented the placing of the propeller in the dead-wood, as being the principal feature of his invention. "*Since* the enrolment of my specification," he says, "I find that the dead-wood, or run of the vessel, *is the only place* in which the said propeller can be advantageously placed, and that a screw of one turn, or two half turns, as a propeller, will be sufficient for every purpose." And "for this reason," and in order to *limit* his claim accordingly, he substitutes for the words which have been just quoted, the following: "I claim as my invention the propeller described in figs. 1, 2, 3, of the drawing annexed to *this memorandum of alteration,* and placed singly *in the centre of the dead-wood,* or run of the vessel, as shown in the figures of the drawing annexed to the original specification." As represented in the drawing annexed to the original specification, the screw is of a single thread; but in the drawings which accompany the Memorandum of Alteration, it is shown as be-

ing either of a single thread, or of a double thread, or a thread of two half turns. Now certainly to alter the specification in the way done by this memorandum, is not to *limit*, but greatly to *extend*, the patentee's original right against the provision of the statute in that respect. For by the original specification no novelty whatever was claimed either as regards the form of the propeller, or the place in which it was to be fixed; while, by the Memorandum of Alteration, he claims to appropriate to himself exclusively, not only the use of the screw with the two half turns, but also the placing of it in the dead-wood.

Mr. Smith's screw has since popularly obtained the name of the *Archimedes' screw;* but the actual screw of Archimedes, as described by Vitruvius, consisted of a spiral fixed within a cylinder, or case, so as to revolve along with it, while the screw of Mr. Smith has no case, and is wholly open to the water. The American invention, mentioned by Marestier, and that of Scott, of Ormiston, were more like the screw of Archimedes, only that the screw in these cases revolved by itself, while the cylinder enclosing them remained stationary.

1836, July. Captain Ericsson patented a propeller consisting of six blades, each of the form of a segment of a screw, attached at equal distances to a cylinder, three of which blades are extended inwards as far as the axis, so that the greater portion of the impinging surface is exterior to the cylinder at a distance from the axis.

1838. Captain George Smith took out a patent for applying two propellers, consisting of plain blades, one on each side of the dead-wood.

1839, Nov. 25. Mr. John Hunt took out a patent for combining a stern propeller and rudder in one; the blades of the propeller were to be of *any* suitable form.

1839, Nov. 26. Mr. George Rennie patented his conoidal propellor, which differs from all others before proposed in this, that the lines of the screw are obtained from the circumvolution of a thread round a cone instead of a cylinder, whereby the diameter of the screw, rearward of the leading part, is progressively diminished, and in proportion thereto the amount of prejudicial resistance.

1839, Jan. 22. Mr. J. C. Haddan patented the "forming and using of screws with openings, or spaces, in the central portions of the threads," whereby "the velocity of the impinging, or propelling surface, is rendered more equal, and a passage afforded for the water through the centre."

1840, May 28. Mr. George Blaxland patented the use of "one or more inclined planes," (not segments of a *screw*, but plain blades,) to be fixed at right angles to a revolving, horizontal shaft, placed in the after part of the keel, forwards of the rudder-post, which inclined planes (are to) work in the water below the water line, in an opening formed in the dead-wood of the vessel," &c.

1830, June 13. Captain Carpenter patented the use of two propellers of a trapezoidal form, to be placed in the stern quarters of the vessel.

1843, Jan. 19. Mr. Thomas Sunderland patented a stern propeller, having blades attached, not immediately to the shaft, but to the ends of a cross-bar affixed to it, and of such a curved form that every point of the outer edge is equi-distant from a straight line drawn through the centre of the shaft.

A writer in a succeeding number adds the following:—

Captain Ericsson's propeller, as patented in this country July 13, 1836, consists of two wheels of wrought iron, formed by a series of spiral plates rivetted to narrow cylinders of the same material, which are connected by radiating spiral arms to the centre. These wheels are attached to shafts, (the one to which the inner wheel is fixed being hollow,) passing through the stern of the vessel, and revolving in opposite directions, each series of plates being so placed on the cylinders." So far from the Appendix to Byrne's observations "on the best means of propelling ships." Upon referring to the specification of this patent, I am able to add, that the number of blades is upon each cylinder eight—that the cylinder is supported by three spiral arms—that a narrow cylinder surrounds the spiral blades—that the two *(which are claimed as one propeller)* revolve at different speeds by means of cogged-wheels, and that they are placed abaft the rudder, (which is cut in two) and supported by a bearing from the false stern, which takes the shaft between the two wheels. The claims are to the whole arrangement of the propeller, as described.

Woodcroft's patent is, I think, dated March 22, 1832, and not November 18, 1826.

Blaxland's patent should follow Carpenter's, being dated November 28th.

In your quotation from Mr. Blaxland's specification, you have omitted the words "propellers," after "inclined planes"—a choice of names being offered by Mr. Blaxland for his blades; and you have added in their place, "not segments of a screw, but plain blades." Upon reading the specification through—the only way, permit me to remark, such a document can be correctly understood—you will see that "in order to determine the angles at which the inclined plane, or planes, is, or are, to be fixed," &c. Mr. B. supplies a diagram, pointing out with singular precision, and in a manner worthy of notice, his mode of ascertaining these angles, which produce a blade whose inner circumference passes over the same distance as its outer does; and this could not possibly be the case were the blades flat. Again, Mr. B. says, "I rivet the inclined planes, which I prefer divided into three or more parts," &c. And here you must understand he is speaking of divided "inclined planes, or propellers;" and then, having fully described the nature of his blade, he secures to himself the right of applying it in an undivided, as well as in a divided state; for with reference to fig. 1, of the specification drawing, he says "the propeller is here shown with an undivided inclined plane," and in fig. 8, shows "an end view of the propeller used in fig. 1." Mr. Blaxland's "inclined plane, or propeller" may, therefore, be described as a short radiating blade, with its angle increasing from its

periphery to its inner circumference, according to the rule laid down, whether the blade be divided into strips, or not, set upon an arm, and at a distance from its boss; and to those who would know full particulars of its powers, it should be mentioned that it has beaten one propeller in France; two in one, and one in another of Her Majesty's steamers—two in the *Jane*, and twelve in Mr. Beale's steam pinnace.

Lond. Mech. Mag.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Kyanized Railroad Sleepers.

James Herron, Civ. Eng., has deposited at the Hall of the Franklin Institute, a section of a *kyanized chesnut sleeper* from the Baltimore and Susquehanna Railroad, which was prepared in July, 1838, laid in August of the same year, and taken up for the purpose of examination in August, 1843, having been in actual service for five years, as is attested by Robert S. Hollins, secretary for the company.

This interesting section, which may be seen at the Hall, is in a perfect state of preservation; and it is stated by the officers of the company, that all the *kyanized* sills are, without a single exception, as sound as the specimen referred to, whilst the unprepared sleepers of the same lot of timber have all decayed.

The great benefit which seems to have been experienced in the case before us, from *kyanizing* chesnut sleepers, is strictly conformable to experience upon several English railways; but this is the most striking example of the advantage of mercurial antiseptics that has fallen under our notice in the history of American railways, and on that account we call attention to it.

Com. Pub.

Burnett's Patent for Preserving Wood, &c.

The plan patented by Sir William Burnett, for the preservation o timber, canvas, cordage, &c., from dry-rot, mildew, moth, and the destructive effects of damp, or the combined action of air and water, is a colorless, metallic salt, (chloride of zinc) prepared for use by solution in water, in the proportion of 1 pound of the substance to 10 gallons of water; which quantity, procurable for the sum of 1*s.* 6*d.*, is sufficient to prepare and preserve half a load of timber. By a hydraulic injecting apparatus, employed in Her Majesty's Dockyard, at Portsmouth, which is capable of saturating twenty loads of timber at a time, the gravity of the wood is increased 64 per cent., although, afterwards, lessened by drying; by a stronger solution than the above, wood, canvas, cordage, &c., are rendered incombustible, and all the men-of-war are, in future, to have their magazines fitted with wood and felt, especially prepared for this purpose; and the solution being colorless, does not affect the color of the materials to which it is applied.

Numerous experiments have been tried, extending over a period

of nine years, to ascertain, with certainty, the effect of the process on various substances. Specimens of English oak, English elm, and Dantzic fir, one of each prepared with the solution, and one of each unprepared, were placed in the fungus pit at Woolwich, on the 25th of August, 1836, and taken out on the 15th of July, 1841, when the prepared specimens were found to be perfectly sound, while the unprepared English oak had a spot of fungus on one end, the English elm decayed, and the Dantzic fir had fungus outside, and was decayed at heart. A quantity of Burnetized deals, with other pieces of the same wood unprepared, were put down in the damp cellar of a house in Chatham Dockyard, where the floors had been repeatedly destroyed by dry-rot, and where large fungi were growing in 1838, and in 1842 all the unprepared wood had become completely rotten, while the Burnetized portion was completely sound, and relaid with more unprepared deals for further experiment. Six pieces of canvas, and three of woolen cloth prepared, and the like samples unprepared, were placed in a hole four feet deep, in a damp situation, and exposed to the sun, where they remained six months; they were then taken up, washed in plain water, and dried, then placed in a deal box, and deposited in a damp sink, but not in contact with water; they were left in this situation nine weeks, and when examined, the prepared articles were perfect as ever, the unprepared perfectly rotten. These are a few of the experiments, and which are sufficient to show the nature of the process, and the powerful effects of the solution, which is now universally adopted in Her Majesty's dockyards, and is coming into very general use.

In confirmation of the reported good qualities of Sir William Burnett's process, we have had the following letter handed to us:—

Tullamore, King's county, Ireland, July 10.

I certify that I have made use of a large quantity of *domestic timber* (beech, elm, and Scotch fir,) in the repairs of my boats on the Grand Canal, which was prepared in Sir William Burnett's process three years since; most of it I find to be perfectly sound, which would not have been the case had it not been so prepared, as I have had repeatedly *Memel timber* decayed in less time in the same situation.

(Signed) THOMAS BARRY.

Mining Journal.

Working of English Railways.

We copy from the "Civil Engineer and Architect's Journal," for September, 1843, a tabular statement, giving the particulars of the working of *twenty* English railways, for the first half of the year, 1843; this table will be found to contain statistics of a character useful to persons interested in such works, and we could wish that a similar degree of attention was more generally paid by the American railroad corporations, to their own statistics, for the reception of which, in a condensed form, our columns will be always open.

COM. PUB.

Tabular Statement for the half year, December 31, 1842, to June 30, 1843.

RAILWAYS.		....	....	RECEIPTS.			PAYMENTS.							....
Names.	Length in miles.	Total Expenditure.	Number of Passengers.	Passengers.	Goods.	Total.	Locomotive Power.	Carriages.	Maintenance of way, and Repairs.	Office Department.	Taxes and Rates.	Total Charges.	Interest.	Profit.
		£		£	£	£	£	£	£	£	£	£	£	£
Greenwich,*	3¾	1,030,108	705,204	21,344		26,587	3,500	3,490	1,044	1,551	3,304	13,957	11,550	1,080
Grand Junction,†	88¾	2,375,134		132,976	49,652	185,093	20,298	29,691	12,675	4,591	2,954	80,320		104,772
Manchester and Bolton,	10	777,956	139,408	11,571	6,293	17,811	1,095	3,110	732	754	268	5,959	5,282	9,008
North Union,	22	613,212		17,731	6,793	25,337	1,466	2,142	1,471	1,236	1,082	7,597	3,249	14,690
Chester and Birkenhead,	14½	509,810		11,491	1,298	13,307	2,110	2,382	1,089	237	172	5,990	2,525	2,837
Leeds and Selby,‡	20		99,782	3,756	8,158	11 914		1,251	567	444	477	2,739		9,175
Brighton,§	56	2,792,193		65,487	9,002	74,490	9,168	18,150	4,980	3.414	3,003	49,827	43,974	
North Midland,	72¾	3,424,766		56,551	46,263	102,814	10,267	13,922	9,012	1,400	2,659	36,760	21,200	44,854
Northern and Eastern Counties,‖	32½	887,055		31,853	3,693	35,547	6,702	6,945	2,033		895	20.324	5,695	10,875
London and Birmingham,¶	113½	5,953,831		306.457	84,735	389,658	32,854	41,141	22,451	5,645	8,747	112,238	39.680	233,924
Midland Counties,	57	1,725,693		40,421	21,064	62,324	10,780	9,498	7,105	3,383	1,378	32,144	12,813	17,367
Great North of England,	74	1,230,604	64,177	19,754	13,225	32,979	2,830	3,497	3,700	1,844	1,184	12,355	14,202	7,00
Sheffield and Rotherham,**	5½		185,234	7.040	953	8,116		2,107	486	371	420	3,384	1,199	3,578
Bolton and Preston,	14½	373,925		3,846	1,468	5,315	2,000	1,170	185		92	3,447		1,867
Great Western,††	118¼	6,651,928	725,127	254,603	75,400	330,003	33,403	54,640	23,985	4,118	8,592	159,232	86,836	82,886
Liverpool and Manchester,	51	1,578,601	225,728	60,752	48,217	108,960	10,182	27,698	4,440	2,193	3,608	48,121	3,777	57,062
Blackwall,	3¾	1,289,080		17,351	927	18,505			600		1,498	15.385	5,553	
Eastern Counties,	50½	2,718,620	999,683			43,182	4,551	3,741	2,556	1,284	1,520	20,355	2,116	20,710
Birmingham and Gloucester,	55	1,470,730		35,514	7,104	42,618	7,968	6,956	6,444	1,290	382	56,046	13,633	4,266
York and North Midland,	27	673,056	165,627	26,369	13,388	45,163	5,846	5,145	1.177	462	974	43,603	3.958	27,600

* Greenwich Railway received for foot passengers £497, and toll £4,746. † Grand Junction paid Liverpool and Manchester Railway £8,016, and for rent £2,093. ‡ Leeds and Selby locomotive power is included in York and North Midland. § Brighton paid Croydon and Greenwich Railway for toll £11,109. ‖ Northern and Eastern paid Eastern Counties Railway for toll £3,749. It should be observed that the office expenses cannot be separated. ¶ London and Birmingham paid Aylesbury Railway for rent £1,250. In addition to the total outlay, there is the sum of £13,966 carried to the depreciation fund. ** Locomotive power not kept distinct. †† Great Western paid Bristol and Exeter, and Cheltenham Railway, for rent, £34,484. In addition to the outlay £5,000 is carried to the depreciation fund.

9*

The Water-Pressure Engine at Freyburg, Saxony. By WILLIAM LEWIS BAKER, Grad. Ins. C. E.

The machine described in this communication was designed by Herrn Brendel in 1823, and constructed in 1824, for draining the "Alte Mördgrube" mine, one of the largest silver mines in the neighborhood of Freyburg, in Saxony. This engine, which is fixed at a depth of 360 feet below the surface of the ground, has two single-acting cast iron cylinders, each 18 inches in diameter, and 9 feet stroke, to the pistons of which are fixed strong timber piston rods, each attached at its upper end by a flat iron rod and chain, to the opposite segments of a horizontal working beam, thus connecting the pistons of the two cylinders, so that, when one is being moved upwards by the pressure of water underneath it, the other is depressed by the weight of all the pump-rods, and other moving parts to which it is connected. The admission and eduction of water from the cylinders is regulated by side valves worked by levers and tappets. The piston-rods give motion to the horizontal arms of two bell-crank levers, the diagonal arms of which move the main pump-rods, working 44 pumps in two sets of 22 each, placed one above another, at an angle of 45° with the horizon, each dipping into the delivery cistern of the pump immediately below it; this is repeated downwards for the whole series; and thus the water is raised from the bottom of the mine to the point where it runs off by an adit. Each pump has a lift of 30 feet 4 inches. The duty performed by this engine is stated by Gerstner,* to be as 70 to 100.

The author then gives a very minute account of the construction of the engine, illustrating the paper by three drawings, giving the general arrangement, and the detailed dimensions of all the working parts.

Remarks.—Mr. Taylor remarked that the water-pressure engine was of Hungarian origin; it was extensively used in Germany, and had lately been much improved in construction, particularly by abandoning the rude mode of placing a series of pumps over each other, as had been described in the paper. He believed that Smeaton erected the first engine of the kind in this country. Trevithick built one about 40 years since, with cylinders of 30 inches diameter. Another was erected by Mr. Fairbairn, and since then one had been built under the direction of Mr. Darlington, with cylinders of 50 inches diameter, and 10 ft. stroke, worked by a force of water of 22 fathoms, through a descending column of 30 inches diameter; the pumps worked by the engine were 42 inches in diameter, raising water from a depth of 22 fathoms; the usual speed of working was 4 strokes per minute, but he had seen it attain six strokes. The concussion produced by the closing of the valve at the end of the stroke, was generally very prejudicial to these engines; but in that made by Mr. Darlington, it was diminished by allowing the large valve to close a short time before the stroke finished, and bringing the piston home with a small valve; by this means no noise was heard beyond that of the rush of the water, and the violent shocks were avoided.

Civ. Eng. & Arch. Journ.

* Gerstner, "Handbuch der Mechanick," published at Vienna in 1834.

Franklin Institute.

Report of the launches of the steam-frigates Raritan and Princeton.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred the subject of determining the amount of friction on the ways for launching the steam-frigates Raritan and Princeton, REPORT:—

That some of their number visited the Navy Yard on the day before the launch of the first class frigate Raritan, for the purpose of consulting with Mr. Lenthall, the United States Naval Constructor, under whose direction the launch was to take place, as to the arrangements to be made for the contemplated observations, Mr. Lenthall entered fully into their views, and promptly tendered every accommodation and assistance that might be found necessary.

The preparations for launching were at that time nearly completed. The launching ways, formed of heavy timber sills, were laid on a foundation of masonry, with a descent of 7.676 feet, in a distance of 120 feet, measured along the plane, or 1 in 15.633, or 30° 40′ slope. They extended from the stem of the ship into the river, to a depth sufficient to allow her to plunge off without striking the bottom. The upper faces of the ways were carefully planed, and lubricated with a thick coating of tallow. On these were laid the bilge-ways, constituting the base of the movable cradle, in which the ship was to rest when launching. Above the bilge-ways was placed a timber blocking, fitted to the mould of the ship, and firmly secured by lashings passed under the keel. The wedges for raising the ship off the keel-blocks and shores, which yet supported her, were inserted between the bilge-ways and the blocking. Arrangements were made by the committee for observations by different methods, and at several points, which will now be described.

A series of vertical lines was marked on the bilge-ways on each side of the ship, at intervals increasing from six inches to six feet. Sights were placed for the guidance of the observer, who was to note the passage of each successive mark: the time, by a chronometer, being noted in tenths of a second, by a second observer; while a third recorded the coincidences of these double notings, on a time table prepared for the purpose. A similar series of marks at larger intervals, the greatest being ten feet, was made on the bilge of the ship; the transit of which was to be noted by an observer, who should mark the time by a chronograph on the seconds dial of a watch. A member of the committee agreed to prepare an apparatus for marking half seconds on a tape to be drawn from a reel by the ship, as she was launched.

On the day appointed, the committee met at the scene of action, and was subdivided into several parties, each charged with one of the posts of observation above described; in addition to which, a party on board the frigate undertook to note the time of passing the vertical timbers of the ship-house; the intervals between which were meas-

ured. The number and variety of independent observations would, it was supposed, afford a reasonable certainty of determining correctly the speed of the vessel at every point of her short career down the ways. This expectation was not realized; the speed from the moment of starting, was greater than had been anticipated, and consequently, the intervals marked for observation were too small to be accurately noted. The apparatus for marking the tape was prepared at such short notice, that no time was allowed for previous trial: the marking pencil was not properly secured to the pendulum, and was displaced soon after starting. This experiment consequently failed. The passage of the last mark of the series on the bilge-ways, was satisfactorily noted on both sides of the ship; and from these observations, together with those made by the party on board, it appears that she traversed 59 feet in 11 seconds. These numbers will be used to determine the coefficient of friction, and may be supposed to furnish a result approximately correct.

The experience acquired on this occasion, confirmed the opinion, that a properly adjusted mechanical arrangement would accomplish the desired object with greater certainty and accuracy, than any personal observations. The committee, therefore, requested two of their members, Messrs. Lukens and Saxton, each to prepare an apparatus for marking time upon a tape, to be in readiness for the launch of the United States steamer Princeton; which was to take place in a few weeks. These were accordingly prepared, and on trials made before the launch, both were found to operate satisfactorily. These two instruments operate on the same general principle, of marking the oscillations of a half second pendulum upon a tape, the end of which is attached to the body whose velocity is to be noted. The marking is effected in Mr. Saxton's apparatus, by a cam on the pendulum rod, which presses down a lever carrying a brass cup charged with vermillion paint. The bottom of the cup is pierced with a small hole, through which a minute quantity of the paint is deposited on the tape whenever the cup touches it. The lever and cup are thrown up by a counter-spring as soon as the cam has passed. In the other apparatus, made by Mr. Lukens, the marking machinery is more complicated; in order to make the stroke and recoil of the marking pen sudden, so as to produce a well defined mark without a trail. The pen is formed of a metal tube closed at the lower end, and pierced with several small holes in the bottom, and around the circumference near the bottom. This cylinder passes through, and nicely fits, an opening in the bottom of a cup which contains the marking ink. When the pen is at rest, its lower end is just within, and fills the opening in the bottom of the ink cup: the ink enters it through the small holes in the circumference, and thence oozing through those in the bottom, keeps that end supplied with marking material. A detached escapement wheel, impelled by a weight; when released from its detent by the pendulum, strikes the pen suddenly down upon the tape, and marks the passing point; a counter-spring instantly throws it up, and supports it in the intervals between the strokes. In both

machines the pendulum is started by a trigger let off by the moving body.

The preparations for the launch of the Princeton, were similar to those made for the Raritan: the grade of the ways was somewhat steeper, being about 1 in 13, and the pressure on a unit of bearing surface was considerably smaller. The estimated weight of the Raritan, when launched, was 1200 tons; the bearing area of the bilge-ways was 755 square feet; the pressure, therefore, was 3,560 lbs. to the foot. The weight of the Princeton, with the machinery on board, at that time was 577 tons; the bearing surface 566 square feet, giving a pressure of 2,280 lbs. to the foot.

The unusual want of buoyancy of the stern of this ship, consequent upon the insertion of the Ericsson propeller, in the place of her dead wood, it was feared might cause her to dip too much on entering the water; to prevent which several empty casks were lashed to the run, a few feet above the keel. As they were placed so high as not to enter the water during the time included in the observations used by the committee, they could have no effect on their results, and, consequently, no further notice of them is necessary.

The position of the vessel was so near the margin of the river, that the extremity of the keel was immersed at the start; and by the close of the time just spoken of, about 20 feet in length was immersed to the average depth of about 2 feet.

The marking instruments were placed one at each side of the vessel—Mr. Lukens' on the north, with 100 feet of tape, and Mr. Saxton's on the south, with 50 feet. The tapes were attached to the bilge-ways, together with a line for detaching them when nearly run out. Mr. Lukens' tape was accidentally displaced at the moment of starting, so that the pen struck at the side of it for some seconds; it was then drawn into its proper line, and was marked from that point to the end. Mr. Saxton's apparatus was more successful, the tape being distinctly marked from the start, and bearing a permanent record of the motion of the vessel. The result of this gratifying experiment is exhibited in the annexed table marked A. Table B shows the results from Mr. Lukens' tape, which, connected with the other, exhibits the ship's motion through nearly 100 feet.

By examining the table A, it will be perceived that the velocity during the first three-fourths of a second, was regularly accelerated, but very slow. In the next half second, an increased rate of acceleration was attained, which is regularly maintained during four seconds. After the lapse of 5¼ seconds, several irregularities occurred, indicating the operation of some retarding cause, the source of which is not ascertained. The only known changes of condition at this time, are, first, the increased immersion of the keel, causing a displacement of not more than two tons of water; and secondly, some possible difference in the lubricating effect of the tallow where it is under the water. The changes in these particulars would seem to be insufficient to produce the remarkable effects observed.

As the data thus obtained, indicate distinct periods in which the ratio of friction has different values; it is thought proper to determine

the coefficients separately for the first three-fourths of a second, and for the interval of 4 seconds, in which there is a regular acceleration; and lastly, for the whole period of 5¼ seconds, in order to connect the observations on the Princeton with the single result obtained from the Raritan.

For the determination of the coefficient of friction, the following formula has been used:—*

Let the weight of the ship be W,

Descent of ways in unit of length $\frac{h}{l}$,

Pressure on ways $W' = W, \frac{\sqrt{l^2 h^2}}{l}$,

Theoretical force down the ways $g' = \frac{g.h}{l}$,

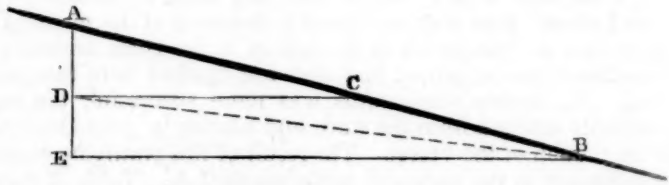
Observed force $g'' = \frac{2s}{t^2}$,

Resistance of friction $R = W. \frac{g' - g''}{g}$,

The coefficient of friction will be $\frac{R}{W'} = \frac{g' - g''}{g} \div \frac{\sqrt{l^2 - h^2}}{l}$,

Equal to the retardation experienced, divided by the velocity acquired

* Another method of considering the subject of friction, upon inclined planes, has been suggested by a member of the committee, which results in a formula different from that we have employed.



Thus, calling A C = S, the space actually slid over in a given time, t, by any body descending an inclined plane.

A B = S', the space which the body would have described by theory in the given time, $t = \frac{1}{2}gt^2$ sin. i, friction being null.

A B E = i, the angle of inclination which the plane forms with the horizon.

D B E = f, the angle of friction due to the body.

Then A E, being the total vertical space through which the body would have fallen in the given time, t, if friction had not existed; and A D, being the actual vertical space fallen through in the given time, t, it follows that D E represents the retardation due to the friction of the body upon the plane A B. D B E will be the angle of friction of the body, and $\frac{DE}{BE}$ will be the tangent of the the angle, f, or coefficient of the friction of motion pertaining to that body.

Knowing then simply the actual time occupied by the sliding body, in descending any measured distance along the plane, the formula, for finding the coefficient of its friction, will be

$$\text{Tang. } f = \text{Tang. } i \left(\frac{S' - S}{S'}\right)$$

By this formula the angle of friction of the Raritan frigate, computed from a time of 11

in the observed time by a body falling freely, multiplied by the ratio of the length to the base, of the plane.

If we apply this formula to the observation on the Raritan, we shall have $h=1, l=15.633, \sqrt{l^2-h^2}=15.277, g'=\frac{32.2}{15.633}=2.0597$ ft. per second, $g''=\frac{118}{112}=.975$ feet per second.

$$\text{Therefore, } \frac{R}{W'}=\frac{1.0846}{32.2}\times\frac{15.633}{15.277}=\frac{1}{29.01}.$$

In the case of the Princeton we have

$$h=1,\ l=13,\ \sqrt{l^2-h^2}=12.966,\ g'=\frac{32.2}{13}=2.477.$$

For the first ¾ seconds,

$$g''=.37, \text{ and } \frac{R}{W'}=\frac{2.107}{32.2}\times\frac{13.}{12.966}=\frac{27.39}{417.5}=\frac{1}{15.24}.$$

For the next 4 seconds,

$$g''=1.74, \text{ and } \frac{R}{W'}=\frac{.733}{32.2}\times\frac{13.}{12.966}=\frac{9.529}{417.5}=\frac{1}{44.97}.$$

For the whole 5¼ secs. $g''=1.42\ \frac{R}{W'}=\frac{13.689}{417.5}=\frac{1}{30.5}.$

This last result represents very nearly the average for the whole length of Mr. Saxton's tape; the distance being 48.8, and the time 8¼ seconds.

The value of g'' is, therefore, 1.43, and $\frac{R}{W'}=\frac{1}{30.67}$.

If we extend our calculation still further, and take the last measurement given by Mr. Luken's tape, we shall find the mean resistance to the ship's motion to continue nearly uniform to that period, notwithstanding the immersion of nearly 100 feet of her length, to an average depth of almost 4 feet.

The value of g'', for this period of 11¼ seconds, is 1.509, and $\frac{R}{W'}=\frac{1}{32.89}$, being somewhat less than the earlier average, because it is less effected by the very high coefficients given in the first ¾ of a second, which involved the friction of rest.

Morin's experiments upon the sliding of plane surfaces of wood upon wood, with coatings of tallow, give an average coefficient of

seconds, occupied in sliding 59 feet, upon a slip of 3° 40′ slope, is 1° 55′, the coefficient of friction, or natural tangent, of that angle being .0336, or nearly 1-30th.

The angle of friction of the Princeton steamer, computed by the same formula, from a time of 5¼ seconds, occupied in sliding 19.62 feet, upon a slip of 4° 25′ slope, is 1° 53′, the coefficient of friction, or natural tangent, of that angle being .0328, or rather more than 1-30th.

The mean of these two results, gives an angle of friction, for launching such vessels as these, of 1° 54′, or a coefficient of friction of very nearly 1-30th.

friction of $\frac{1}{13.7}$, and when the surfaces moved from rest of $\frac{1}{6.2}$.*

The greatest value of the coefficient of friction found by the committee, is $\frac{1}{15.2}$; the average of the two experiments, upon the Raritan and Princeton is $\frac{1}{29.8}$. All the errors, if any exist, in the experiments of the committee, would tend to make the coefficient appear greater than it really is, and yet it is less than one-half the average determined by the experiments of Morin.

The thickness of the coating of grease, in these cases, was more than one-fourth of an inch; and the great pressure must have rendered it liquid as the vessel passed over it—the heat generated being so great as to produce much smoking of the tallow, near the end of the launch.

TABLE A.

Measurement by Mr. Saxton's Tape.		
Time in seconds.	Distance in feet and inches.	Interval in feet and inches.
¼	¼	¼
½	2½	2¼
1¼	9¼	6¾
1½	1 8½	11
2¼	3 0¾	1 4½
2½	4 8¾	1 8
3¼	6 11	2 2¼
3½	9 5⅛	2 6⅛
4¼	12 5¼	3 0⅛
4½	15 9⅛	3 3⅞
5¼	19 7⅜	3 10¼
5½	23 5¼	3 10⅜
6¼	28 1⅛	4 7⅜
6½	32 6⅜	4 5¼
7¼	37 8	5 1⅝
7½	42 6½	4 10½
8¼	48 8	6 1½

TABLE B.

Measurement on Mr. Lukens' Tape. The first mark on this tape is at the distance of 16 feet 9 inches from zero. The corresponding time is taken from the other tape.		
Time in seconds.	Distance in feet and inches.	Interval in feet and inches.
5	16 9	4 2
5½	20 11	4 3½
6	25 2¼	4 4½
6½	29 6¾	6 4½
7	35 11½	5 6½
7½	41 6	
8	no mark.	12
8½	53 6	
9	61 5½	7 11½
9½	68 0½	6 7
10	75 5½	7 5
10½	83 2½	7 9
11	91 5½	8 3
11½	99 8½	8 3

Supposed.

By order of the Committee,

William Hamilton, Actuary.

Philadelphia, January 11th, 1844.

On Thomas Shriver's Bow-Spring for Carriages.

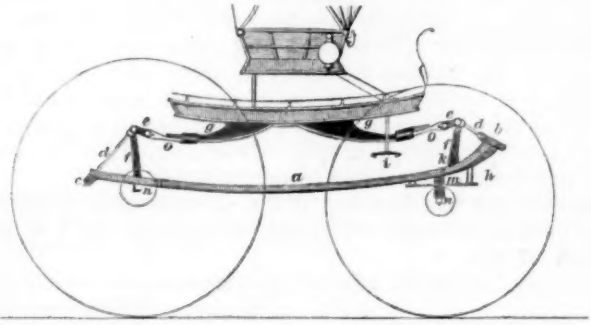
The Committee on Science and the Arts, constituted by the Franklin Institute, of the State of Pennsylvania for the Promotion of the Mechanic Arts, to whom was referred for examination the Bow-Spring for Carriages, invented by Thomas Shriver, of Cumberland, Maryland, Report:—

That they have examined two carriages constructed upon Mr. Shriver's plan, which may be described as follows, having reference

* In a note appended to his table of friction, given in the "Aide Memoire," page 309, Morin remarks, that when the unguent is continually renewed, and uniformly distributed, this ratio can be reduced to 1-20th. In a table published in the same work, on page 307, he states *the friction of rest*, between woods having unguents of tallow, at 1-10th.

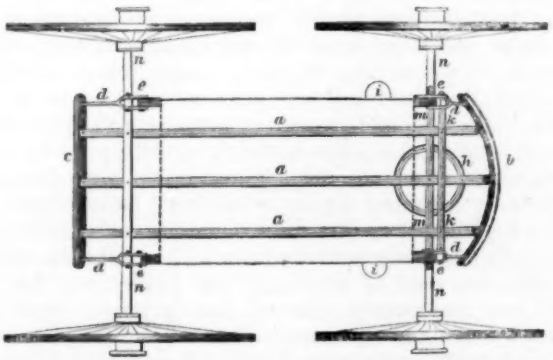
to a drawing hereto attached. The running gears, or frame, which supports the carriage body, mainly consists of three longitudinal pieces, or bows, of wood, *a*, *a*, *a*, framed to the bolster, *n*, which is attached to the hindermost axletree, and to two transom pieces, or bolsters, *m* and *k*, fixed over the front axletree—the piece, *m*, being under the pieces *a*, and resting on the pivot of the front axle—and the piece *k*, being on the pieces *a*, and extending upon each side about six inches beyond them. Upon the ends of the transom-piece *k*, and upon the bolster of the hindmost axle, posts, *f*, are framed, which are

Fig. 1.



a, *a*, *a*, Longitudinal Bow-Springs.
b, *b*, Front cross bow-spring.
c, *c*, Back do. do.
d, *d*, Iron stays.
e, *e*, *e*, *e*, Iron links connct'g leather brace.
f, *f*, Wooden suspension posts.
g, *g*, Body springs.
h, *h*, Iron pivot ring.
i, *i*, Steps.
k, *k*, Spring bolster.
m, *m*, Pivot bolster.
n, *n*, Axle, wooden part.
p, *p*, Axle, iron part.
o, *o*, Leather susp'g braces.

Fig. 2.



connected to the ends of the two cross pieces, *c* and *b*, by iron rods, *d*; the cross pieces, *c* and *b*, being framed and secured to the ends of the bow pieces, *a*, at a suitable bevel, to resist the tension strain of the rods, *d*. The upper ends of the posts, *f*, the rods, *d*, and the links, *e*.

are connected by bolts to the leather straps, *o*, and springs, *g*, which are attached to, and support, the carriage body. In light carriages, the front piece, *b*, is curved, as represented in the drawing, but in heavy vehicles, or stage coaches, it is usually made straight. The whole carriage frame operates as a spring, when pressed by the weight and action of the carriage body. The points, *e*, *e*, are drawn towards the centre, and cause the posts, *f*, to act upon each of the axles as a fulcrum, bending the bows, *a*, downwards in the centre, and upwards at the ends, by the tension of the rods, *d*.

The committee, after a minute examination of the subject, feel justified in expressing a very favorable opinion of these springs, combining, as they certainly do in a high degree, the essential qualities of lightness, simplicity, cheapness, and durability. This opinion is sustained by the written testimony of some who have extensively used them, and by the experience of several members of the committee, who have ridden in, and examined, both heavy stage coaches, and light carriages, equipped with bow-springs, all of which are successful, and received their decided approbation.

In the drawing attached, fig. 1, is a side elevation of the body of a light carriage constructed with these springs; and fig. 2, a horizontal projection, or plan.

By order of the Committee,

WILLIAM HAMILTON, Actuary.

Philadelphia, December 14th, 1843.

On Calderhead's Carpet Loom.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination the question of the novelty of the Loom devised by Alexander Calderhead, for weaving carpets, REPORT:—

That the main features of this invention, are placing the pattern cylinder under the warp, and causing it to act upon perpendicular needles, each of which has an eye through which a thread of the warp is passed, thus enabling each particular thread to be lifted by the pattern, at the proper moment, to produce a shed for the weft to pass through, and form a point in the figure of the fabric in hand.

The committee have not the slightest doubt, that Alexander Calderhead actually invented the improved loom before them, and think he deserves the highest credit for the ingenuity and perseverance with which, through many discouragements, he has labored to bring his loom to its present state of simplicity and perfection; and the committee will here incidentally observe, that they have good reason to believe that looms upon this simple plan will be found highly useful for weaving carpets, and similar fabrics of a coarse texture.

Nevertheless, an examination of previous patents has brought the committee to the conclusion, that the same form of loom, in all its essentials, has been before devised, and made the subject of a patent, by C. M. H. Molinard, which passed the Great Seal of England on

the 9th of April, 1833, (see Newton's London Journal of Arts, &c., vol. xv. conjoined series, page 287,) where the following description will be found:—

"The present invention is to place the roller which carries the pierced cards under the warp threads, in the back part of the loom, and to cause the pierced cards as they successively come into operation, to act against the under parts of a series of perpendicular needles, through the eyes of which the warp threads are severally passed."

This description precisely applies to the loom before us, which, therefore, *cannot be regarded as a new invention.*

By order of the Committee,

WILLIAM HAMILTON, Actuary.

Philadelphia, April 13th, 1843.

On Laubach's Blacksmith's Tuyere Iron.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination a Patent Tuyere Iron for smiths' forges, invented by Joseph Laubach, of Middletown, Dauphin county, Pennsylvania, REPORT:—

That they have examined the model of Laubach's Patent Tuyere Iron, with a revolving, or vibrating, hearth.

The improvement consists of a vertical cast-iron cylinder, about 8 or 10 inches in length, and from 4 to 5 inches in diameter, with a concave flanch at the upper end, that corresponds with and forms the bottom of the hearth; this flanch also projects inward, and contracts the opening in the cylinder to about 2 inches diameter; this aperture is regulated by a sort of triangular valve of cast-iron fixed on a rod that passes out in front of the forge, (similar to a throttle valve,) this valve regulates the quantity of blast, and closes the aperture when required, to prevent the small coal, or cinder, from falling into the cylinder, which is provided with a sliding bottom that may be withdrawn when necessary to discharge the coal, or cinder, that may have accumulated in the cylinder. There is a horizontal tube projecting from the side of the cylinder to receive the pipe of the bellows.

We believe the arrangement is new. The claim set forth by the inventor, is for constructing the blacksmith's forge with a revolving, or vibratory, hearth; and in combination therewith, the cylinder with a basined rim, forming part of the hearth, and having a tube to receive the nozzle of the bellows: said cylinder receiving the blast from the bellows, and serving as a receiver for the small cinder, as before described.

The committee are of opinion that it is superior to any of the former tuyeres that have been brought forward; they are, moreover, strengthened in their opinion by many certificates, which have been given of its superiority by persons who have made a trial of it, and would, therefore, recommend it to the notice of the public.

By order of the Committee,

WILLIAM HAMILTON, Actuary.

Philadelphia, October 12th, 1843.

English Patents.

Specification of a Patent granted to William Edward Newton, of Chancery Lane, *for improvements in manufacturing lime, cement, artificial stone, and such other compositions more particularly applicable to working under water, and in constructing buildings and other works, which are exposed to damp. Sealed the 3rd of April,* 1841.

This invention consists, firstly, in the formation, by certain new processes, of an hydraulic lime and cement, which has the property of becoming hard and solid, when under water, or exposed in damp situations; secondly, in the application of the same principles to the hardening of soft stones, for the purpose of making hard artificial stones; thirdly, in the employment of the same process for hardening wood, and preserving iron from the effects of damp, &c.

The following is the principle upon which the invention is founded, and the methods employed for carrying it into effect: The property which certain sorts of lime possess, of being hydraulic, or hardening under water, is caused by a certain combination of the lime with silica, alumina, and sometimes also with oxide of manganese, and oxide of iron. The object then of this invention, is to facilitate the combination of the lime with those oxides, by means of agents not hitherto employed. Thus, in operating by the dry method, as is generally the case, instead of calcining the lime-stone, or lime, with sand and clay, the inventor, in order to facilitate the combination of the silica and alumina with the lime, introduces a small quantity of potash, or soda, in the state of carbonate, sulphate, or chloride, or of any other salt of these bases, susceptible of decomposition, or becoming a silicate, when such calcination takes place. The salt of potash, or soda, the quantity of which varies from three to six per cent. to the quantity of lime, is employed in the state of solution, so as to penetrate and mix better with the alkaline salt in the chalk, or slacked lime. Calcination effects the rest, in the ordinary manner.

In order to combine, or incorporate, more equally by the dry method, the alumina, and the oxides of manganese, and of iron, with the lime, the sulphates of these bases are first decomposed by the slacked lime, by making a paste with a solution of the sulphates, mixed with the lime. This paste, into which the sulphates in question enter, in the proportion of from six to ten per cent, of the lime, is then calcined, in order to produce an hydraulic lime. All sorts of lime are made hydraulic, by the humid method, by mixing slacked lime with solutions of alum, or sulphates of alumina; but the best method consists in employing a solution of the silicates of potash, or of soda, called liquor of flints, or soluble glass. An hydraulic cement may also be made, which will serve for the manufacture of architectural ornaments, by making a paste of pulverized chalk, and a solution of the silicate of potash, or of soda: in working with this plaster, it becomes much harder than ordinary plaster.

These same silicates of potash, or soda, dissolved in water, will also harden chalk, or soft and porous stones, and transform them, artificially, into hard stones. In order to do this, these soft stones, either rough, or cut into their proper forms, must be soaked in a solution of the silicate, either warm or cold, and allowed to remain there a longer, or shorter time, according to the degree of hardness which it may be necessary to give them; after which, they must be taken out and left exposed to the air. At the end of a few days, stones, thus prepared, will have acquired a hardness equal to that of marble; and this quality, in a little time, pervades the whole mass; for if, for the purpose of polishing, the outer coat, or surface, be removed, the inner one, which at first is not so hard, will harden in its turn, by exposure to the air. This takes place as far as the silicate has been able to penetrate. A more superficial hardness is obtained, by applying the solution of the silicate of potash, or soda, by means of a brush. It is in this manner that walls, constructed of chalk and mortar, may be hardened. Sculpture, and various other objects, which may be made, or prepared, in chalk, may be hardened, and afterwards serve for decorating buildings, and other purposes, without the fear of their becoming injured by frost or damp. Chalk, hardened in this manner, may also be used as a substitute for the stones now employed by lithographers. Plaster models may also be hardened, by placing them, for some time, in a solution of the silicate; but it would be still better to add a portion of the solution to the paste, at the time of making the model, or using the plaster. The silicate of potash, or soda, is prepared by fusing one part of white siliceous matter with from one and a half to two parts of potash, or soda, in the ordinary reverberatory furnaces, or in a glass maker's, or iron, crucible. The solutions may be used of any density for plaster; but they should be weaker for chalk. In the last place, the inventor has found that the silicates of potash, or soda, when dissolved in water, decompose spontaneously in the air, and cover the objects, to which their solution has been applied, with a strong covering, or layer; therefore, by applying the solution of silicate of potash, or of soda, to polished iron, and allowing it to dry in the air, the metal is preserved from oxidation. By soaking wood many times in this solution, and allowing it to dry in the open air, every time after it has been placed therein, it becomes so much penetrated with silica, that it acquires a considerable density and degree of indestructibility.

The solution of the silicate of potash is not the only substance which, by being injected into porous bodies, tends to harden them. A mixture, made from a solution of bicarbonate of ammonia, and of chloride of magnesium, may be successfully employed; or a mixture of the solutions of ammonia and chloride of calcium, may be used. In these latter cases, instead of having siliceous injections, they are either magnesian or calcareous. Soft and porous stones may also be considerably hardened, and defended from the action of damp, by first well drying them, and then dipping, or steeping, them in sulphur, or some natural, or artificial resinous, or bituminous, substance, rendered liquid by heat.

The patentee claims, firstly, the application of certain new means, to change or convert all descriptions of lime into hydraulic limes and cements, or such as become hard under water, or when exposed in damp situations, by combining these limes and cements with silica, alumina, the oxide of manganese, or the oxide of iron, either by the dry, or humid method. Secondly, the manufacture of hard artificial stones from chalk, plaster, and all porous stones in general, by injecting into them, or imbuing them, with silica, or the carbonates of magnesia, or lime, by any of the above described processes; or by causing them, by virtue of their porous nature, to absorb either melted sulphur, or bituminous, resinous, or fatty matters, properly liquified by means of heat. Thirdly, in the employment of the silicates of potash, or soda, for making, or forming, a stony plaster, or coating, upon a variety of substances, thereby preventing iron from becoming rusty, or oxidized, and rendering wood and other organic matters harder, and not liable to decay.—[Enrolled in the Petty Bag Office, Sept. 1841.]

Lond. Journ. Arts & Scien.

Specification of a Patent granted to JOHN GEORGE SHIPLEY, *for certain improvements in Saddles; patent dated October* 6, 1842; *specification enrolled April* 6, 1843.

The first of these improvements consists in having the "pannel" quite detached from the "tree:" in saddles this has not heretofore been the case, which is the cause of frequent annoyance; as, for instance, when the pannel gets wet, the saddle cannot be put before a fire to dry, because the other materials of which it is composed are liable to be injured by the heat. Mr. Shipley attaches the "pannel" to the "tree" with springs, which, when pushed into their places, are not easily withdrawn, but yield to pressure, applied for the express purpose, when the pannel is required to be taken out to dry, repair, &c. To the under side of the "tree" there are thongs attached, by which movable pieces of thick felt lining may be attached thereto, and one piece readily changed for another, so that the same saddle which fits one animal may be made in a few minutes to answer for a larger. These thongs also serve to attach metal plates by, instead of the lining, on occasions when it is required to carry a definite weight, as in racing, or steeple chases. Mr. S. also forms the "tree" of bars of steel and whalebone, or either separately. The "straining" is formed of whalebone and canvas, being attached to the saddle in the usual manner.

The patentee claims, 1. The connecting the "pannel" to the "tree" with springs, or hooks.

2. The using of movable felt linings.

3. The attaching of metallic plates for additional weight.

4. The formation of the "tree" of bars of steel and whalebone, separate or combined.

Lond. Mechanics' Magazine.

Specification of a Patent granted to PETER KAGENBUSCH, *for certain improvements in the treatment of the Alum Rock, or Schist, and in the manufacture and application of the products derived therefrom. Patent dated 13th October,* 1842 ; *specification enrolled 13th of April,* 1843.

Mr. Kagenbusch makes four distinct claims:—The first is, for making "water heaps," or heaps of the alum shale broken small, and sprinkled with water as the heap is laid. The heaps are to be plastered over in the usual way, and are to stand from three to eight months.

The 2nd. For burning these "water heaps," at the expiration of this time in kilns, or close heaps with *turf;* wood or coal may be used.

The 3rd. For steeping the alum shale, when burned, in the pits along with kelp, or for steeping kelp in raw alum liquor, in the proportion of three quarters of a ton of kelp to as much alum shale, or alum liquor, as will yield one ton of alum.

And the 4th. For burning the exhausted shale on iron plates alone, to make puzzolana, or with lime, in kilns—made into bricks, or lumps, for hydraulic cement.

In order fully to appreciate these improvements, it is necessary to inform our readers, that the alum rock on the Yorkshire coast yields, besides alum, another salt in equal quantity, which is a mixed sulphate of magnesia and iron. This salt formerly was suffered to run into the sea, but of late years about one-half of it has been preserved for sale in all the works—the Boulby works alone recovering the whole of the sulphate of magnesia entirely free from iron. About one ton of pure sulphate of magnesia may be obtained for every ton of alum, by proper management.

It is well known that some of the alum rocks on the Continent, yield alum by spontaneous decomposition, which is the object intended to be effected by the first claim in the present patent; and it is equally well known that the Yorkshire alum schist will not, and the fact is noticed in a paper published in vol. xii, of the Phil. Trans. for 1676, page 1052, by D. Colwell, Esq., in which he says, "the rock exposed to the air and moisture, crumbles and produces green vitriol, but being burned, is fit for alum." And we have the authority of the late Mr. Sowerby, of Whitby, that such a mode of heap making was tried at the Mulgrave works without success.

The second claim is for the employment of turf as fuel.

The third claim is for the exclusive privilege of "advancing backwards" to the rudest mode of employing kelp, described in the paper above alluded to, as "practiced commonly in the alum works in Yorkshire, from Scarboro' to the river Tees," but long since laid aside.

Muriate, or sulphate of potash, or sulphate of ammonia, are now used by alum makers as the source of the alkali necessary to form alum—the potash salts being obtained from kelp.

One ton of absolutely pure muriate of potash (K Cl) will yield potash equivalent to 6¼ tons of alum; but it is found, in practice, that not more than from 4 to 5 tons of alum are produced from one ton of the muriate of potash of commerce. Now, one ton of kelp yields from 5 to 6 cwt. of such muriate. The patentee, then, we see, employs about the *practical* equivalent of kelp to produce a ton of alum, but he would appear to be altogether ignorant of the fact, that the carbonate of soda, and sulphuret of sodium included in the kelp, will, as far as they go, decompose his alum, and that the sulphate of soda will remain in his "mother liquors," to contaminate the sulphate of magnesia, by which means he will commit, we hope, an *involuntary* fraud upon the purchasers of this latter salt.

There is another mischief to the alum maker, in this rude mode of employing kelp, which may not be generally anticipated. An eminent chemist has informed us, that he has proved the presence of sulphocyanogen compounds in kelp, by their producing the characteristic blood red color with the iron in the alum liquor. This has already been productive of serious injury to the alum in the Mulgrave Works, from the employment of muriate of potash drenched with kelp "mother liquors."

The fourth improvement, "for burning the exhausted shale on iron plates alone," is not likely to be interfered with by cement makers, whose object is to make money at the same time.

It has been for a long time the opinion of the best chemical authorities that the "artificial alum makers," on the Tyne, will, in time, supersede the "natural alum makers," as they are incorrectly termed, seeing that the process followed by each is equally artificial; and these *improvements* do not tend, in the slightest degree, to shake that opinion. Ibid.

Mechanics, Physics, and Chemistry.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the protection afforded to Iron by a coating of Zinc.

In the number of the "*Civil Engineer and Architect's Journal*," for November, 1843, page 386, there is an abstract of the proceedings of the Institution of Civil Engineers, relating to the subject of the protection of iron, by what has been very improperly termed *galvanizing* it; the term zincing is certainly much more appropriate, as the process of covering the iron with zinc is perfectly analogous to that of tinning.

When the patent was obtained for this process, by Mr. Sorel, it was believed that a coating of zinc would effectually protect iron from oxidation, even in those parts which happened not to be covered, or from which the zinc might be accidentally abraded. The fallacy of this assertion was, however, at a very early day, practically demonstrated. Zinced sheet iron was used as a covering for roofs, in the city of New York, soon after the issuing of the patent, but the protec-

tion afforded appeared to be merely mechanical, like that of covering sheet iron with tin; wherever there were flaws in the iron, the water and air which came into contact with the uncovered part, appeared to act more rapidly than upon sheets of common iron. Specimens of iron, thus corroded after a brief exposure to the weather, were sent to the writer of this article for examination, in consequence of the interest he had taken in a process then deemed so promising, and which seemed to be justified by the known laws of galvanism.

It now appears manifest that the resulting failure has been produced by the impurities always existing in the zinc of commerce, and from which it cannot be readily freed. It also is now known that if the zinc could be obtained in a state of absolute purity, it would be rapidly deteriorated in the act of applying it to the iron in the ordinary way. In the article referred to, it is remarked, that "zinc, like most metals in commerce, is not to be met with pure; in the other metals, however, the impurities do not generally tend to the injury of the metals with which they are combined: such, however, is not the case with zinc and its impurities, as when in contact with moisture, they generate a galvanic action, by which the zinc is rapidly destroyed. Those who have made use of zinc, especially where it has been exposed to exciting fluids, such as milk, or other fluid, easily converted into acid, are well aware of the rapidity of its destruction." As the result of the facts thus stated, it is contended "that impure zinc being itself so destructible, is of little value, as it cannot afford protection to any other metal which may be coated with it; and, therefore, coating iron with melted zinc (of commerce) must be objectionable."

In a report, made by M. Dumas, to the French Academy, he says, "that zincing of iron by steeping it in a bath of melted zinc, has many inconveniences: besides, the iron combining with the zinc, constitutes a very brittle, superficial alloy, the iron losing its tenacity." In this process also the zinc, if pure at first, will itself become deteriorated, as it will rapidly, in its fused state, combine with a portion of the iron which it is intended to cover, and will become an alloy of that metal.

Mr. F. Pellatt, in the paper above referred to, proposes to coat iron with zinc by the electro process, which, he states, will cause the pure zinc only to be deposited on the iron, and the amalgamation which takes place when the melted metal is used, is altogether avoided. In proof of the goodness of the process, it is stated that "some thin plates which had been exposed for eight months on roofs in London, did not exhibit any appearance of rust." This process is represented as easily performed on any scale, but Mr. Pellatt "had not made accurate experiments as to the efficacy of the process, when applied to iron exposed to the action of sea-water; but he feared the result on account of the formation of muriate of zinc."

It is believed that there are but few chemists who will not participate in the fear last expressed, for, should it eventually appear that the zincing, when effected by the electro process, will stand the test of time on sheets used for roofing, or otherwise exposed to the action of fresh water only, which may be fairly doubted, it would not follow

that it would be permanent when exposed to saline mixtures, such as the muriates, and others, existing in sea-water.

The English have built a large number of iron vessels, but the writer is not aware that any attempt has been made there to protect them by the zincing process, and the foregoing remarks may serve to show why this has not been done. The process has failed in affording protection under circumstances less trying than that of an exposure to sea-water, and listening to the dictates of common prudence, they have avoided the venturing upon an experiment not sanctioned by the observations already made, and which could not be tried on so large a scale, but at a cost which it would be temerity to encounter in the face of anticipated failure.

Practical Remarks on Blast Furnaces. By GEORGE THOMSON, Esq., Mining Engineer.

There is a manifest absence of anything like correct principle in iron smelting; and, although the reduction of ore by cementation may be an easily explained operation, yet, the peculiar combinations brought to bear in the blast furnace, seem to present a problem which chemical science is as yet unable to explain.

In the attempted solutions of the problem, a too limited number of facts have been generally considered, and generalizations attempted, from facts bearing partially on unvaried conditions. Following the system of induction, if a true principle is only to be attained through the medium of facts in every variety, and under every possible condition, the object may be assisted, in some measure, by my laying before the Society a few facts which have come under my own observation, and may be peculiar. The results given are divided into three principal conditions, viz., 1st, as respects the direct influence, *cæteris paribus*, of different material. 2nd. Influence of shape and size. 3rd. Influence of blast, as to diffusion, pressure, or quantity.

1st. *Influence of Material.*—Although *all* the materials used in smelting have a certain influence; it is the coal which gives the most extraordinary results as respects "yield." A few results of various coals, are, therefore, collected into the following table from my own immediate observations. The word "yield," is used to denote the comparative quantity of coals used in the furnace, to produce, or to smelt, a ton of iron. In the table, the weekly quantity of iron given, as produced by hot blast, is small in comparison with what is now made at most furnaces; yet these are the more correct *comparative* results, having been attained with like conditions of size, shape, number of tuyeres, &c. Since that time, the shape and size of furnaces have been materially altered, as well as other conditions, and the make greatly increased.

Referring to the table, the first three coals are found in the same coal field, and at no very great depth from each other. The cold blast results of these came directly under my own observation, and

are taken from several years' work; the hot blast results are from a neighboring work, and subject to similar conditions in almost every respect. Here, then, in the same coal field, are three different coals, which, when under similar conditions with cold blast, give very different results; so much so as to have taken nearly twice as much of one kind of coal to make a ton of iron as of another (yard coal 5½ tons, clod coal 3 tons,) but when the hot blast is applied, we find they are very nearly assimilated, so that, upon the coal which works *best* with cold blast, that application has scarcely any effect, while on the inferior coal it has a most surprising one.

TABLE No. 1.

PLACES.	COALS.			RESULTS.					
				Cold Blast.		Hot Blast.			
	No.	Local Names.	Loss in Coking.	Coal to a Ton of Iron in Furnace.	Weekly Produce from one Furnace.	"Raw," or Coked.	Coal to a Ton of Iron in Furnace.	Weekly Produce from one Furnace.
Shropshire, (Lightmoor Works,)	1	Clod Coal,	45 per cent.	3 Tons.	70 Tons.	Coked.	2½ Tons.	80 Tons.
	2	Yard Coal,	50 "	5 to 5½	40	Coked.	3½ to 3	80 "
	3	Little Flint Coal,	50 "	4	50 to 60	Coked.	2½ to 3	80 "
South Staffordshire, Wednesbury Work,)	4	Thick Coal,	Uncoked.	2½ to 3	50 to 60			"
	5	Tipton Coal,	45 per cent.	3	60	Raw.	2½	80 "
North Staffordshire, (Fenton Park,)	6	Ash Coal,	45 "	5½	35	Raw.	2½	60 "
	7	Rider Coal,	55 "	7½	25	½ ck. ½ rw. Coked.	3½ 4½	45 " 40 "

DESCRIPTION OF COALS.

No. 1 is soft, stratified, and dull; horizontal sections filled with carbonaceous matter; burns with a white ash; produces a soft coke, which retains carbonaceous matter in divisions.

No. 2, rather hard, cubical and bright; calcareous matter in transverse divisions; burns to a brown ash; produces a hard coke, and is considered very sulphury.

No. 3, hard, cubical, shining; burns to a white ash; produces a very hard coke.

No. 4, is of various stratifications, differing in character; is generally known.

No. 5, Schistous, very friable, with carbonaceous matter between horizontal layers.

No. 6, bright, conchoidal, free burning, and renders a white ash; is preferred for burning the china and "pottery ware" of the district.

No. 7, bright, conchoidal, burns very hot, leaves a brown ash. A stratum of pyrites lies directly below it in the coal field of about 6 inches thick.

The two next coals in the table from the Wolverhampton coal field, show a similar result. The sixth and seventh, or the last two coals

of table No. 1, belong to North Staffordshire—the district of the "Potteries." There my results are also given from a direct personal observation of several years; and I do not think I err in saying, that the materials of this district, taking coal and iron stone together, are the worst in the kingdom for iron smelting. The coals given are compared under precisely similar conditions, both with cold and hot blast, and, although obtained from the working of a very small furnace, (only 32 feet high,) the *comparative* results will not be affected thereby. They lie very close to each other, being merely separated by a stratum of shale a few feet in thickness, often less, and, consequently, show how great a difference occurs, not only in different districts, but within a few yards, vertically, of the same field.

With modifications of shape, and increase of size, (to which we shall attend more particularly under that head,) we were ultimately able to work No. 6, (ash coal) in the furnace without coking, and at a consumption of only 2½ tons to the ton of iron, with a make of upwards of 70 tons a week; but No. 7, (rider coal,) although these conditions altered the make considerably, and the yield slightly, we were never able to work *without* coking; again and again we tried to do so by commencing with a small quantity, and gradually increasing it, but in vain: every increase of this coal to the burden, without coking, was followed by a decrease of yield, make, and quality.

As regards iron stone, the effects of different qualities are not so striking as those of coal, with respect to *yield*, but they have a great influence on the *quality* of the iron produced. For instance, that which is known as the Shropshire penny stone—a peculiar kind of argillaceous iron stone found in small nodules imbedded in a stratum of indurated clay—and containing about 30 to 35 per cent. of iron, is supposed to give the peculiar strength and toughness to the Shropshire pig iron. When another iron stone, (siliceous) locally termed "crawstone," which is found partially stratified in a bed of sandstone rock, is mixed with the pennystone, even in proportion of 1 to 10, the effect is very observable in making the iron much more fluid, although it retains its stoutness. Again, the effect of the "red ore" of Cumberland, or peroxide of iron, mixed with argillaceous, or other iron stone, is well known; it adds in every case very materially to the strength of the iron, and the effect is especially so with the hot blast. Forge cinder, which is a protoxide of iron, mixed with siliceous, or other foreign matter, has a directly contrary effect, both with cold and hot blast,—so much so indeed, that I have seen hot blast iron which had been made with a large proportion of "cinder," so weak as to break into several pieces when dropped on the ground from the height of a couple of feet. I may here remark, that it is not surprising that we should hear so many conflicting opinions on the *strength* of hot blast pigs, by those who only quote results without considering the conditions which affect them.

These results on the quality of iron by the use of different kinds of iron stone, are very general, but such effects are well known, and are constant; and when we consider that there is only one kind of iron,

in fact, surely it is worthy the attention of the scientific to inquire whence arise such differences, and how they should be produced by a simple mixture of "red ore," or of "forge cinder."

2nd. *Influence of Shape and Size.*—We now come to a few results connected with the shape of furnaces; and on this point there seems to be at different times a ruling fashion. At the time of making the experiment to which I shall first refer, which was before the hot blast had been brought into notice, the prevailing fashion in England was to make the furnaces as narrow as possible, both at the "neck," (or filling place,) and at the "hearth." The furnace on which the experiment was made, was at Lightmoor, in Shropshire. the shape and size of which is represented in Fig. 1. It worked worse than any of the others with the same coal, which was a mixture of those already referred to in table 1; and the only difference of its shape, compared with the others, is in being about 6 to 9 inches wider at the boshes, and 3 feet less in height.

Fig. 1.

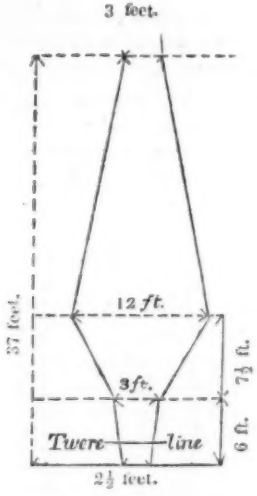
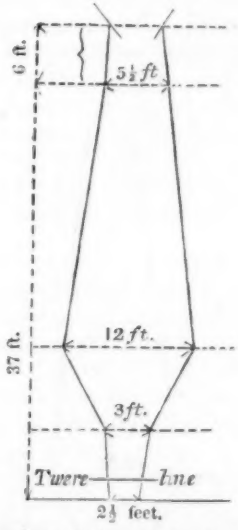


Fig. 2.



This furnace consumed about 5 tons of coal in producing a ton of iron, and made only about 40 tons per week. The alteration made upon it was very simple to appearance, consisting only of widening the top from 3 feet, to 5½ feet diameter, and carrying that width perpendicularly up 6 feet higher; also placing two filling holes, one on each side, over tuyeres, instead of one in the middle, merely, as it were, placing a cylinder of 5½ feet diameter, and 6 feet high upon the top, as represented in Fig. 2.

Simple as the alteration appears, however, it was followed by very extraordinary results; the moment the charge arrived at the bottom

the iron, from hard forge, became fine No. 1. The burden was accordingly increased from time to time, until this furnace, with the same material, and same blast, made 60 *tons* per week of good forge pigs, with a consumption of only 3½ *tons* of coal to a ton of iron. The result is not attributable to the widening and double filling holes *alone;* for the effect was repeatedly tried by filling holes at the *original height, directly under* the upper ones, and in every case we had to take burden off to make an equal quality, thereby reducing both the quantity and the yield.

Mr. Gibbons, of Corbyns Hall Furnaces, near Dudley, has arrived at very striking results with cold blast, by alteration of shape, and increase of size. He states in his publication on the subject, that he was led to the idea by observing the well known fact, that furnaces, especially cold blast ones, scarcely ever come into full work until six months after they have been blown in; and also, that every year, so long as the "boshing" of the furnace is not wholly gone, they improve their work, both in yield and in quantity: further, in observing that furnaces, when blown out, although they had not been working for more than six or eight months, were materially altered from their original shape. By studying the natural shape, as it might be termed, he has arrived at an improved form, as at fig. 4.

Fig. 3.

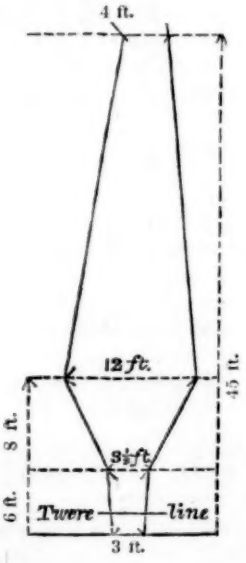
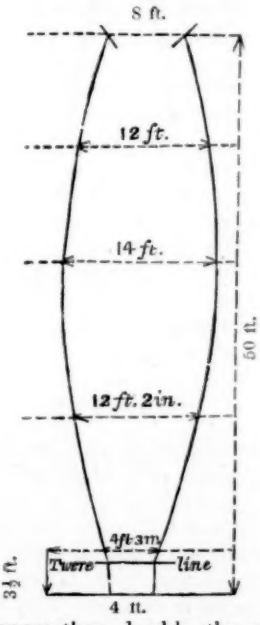


Fig. 4.



This improved furnace, fig. 4, has more than double the capacity of his original one, fig. 3, and the larger content is in the *upper half:* the top is 8 feet diameter, and there are four filling holes. The greatest produce of his original furnace, he states to have been 74 tons per

week, while that of the improved one has reached 115 tons in one week. This is by *cold blast*, with a density of only 1 lb. 13 oz. per inch at the tuyere.

Mr. Gibbons' opinion, like that of many others is, that with the hot blast, the shape, or the size, has very little effect; but that this is not the case, is now well known.

3rd. *Influence of Blast.*—In cold blast working, some practical men hold that the density of the blast should not exceed 2 lbs. to the inch, while others work it as high as 3 lbs. to the inch, or even more. In re-smelting also in the cupola, many prefer the fanners, which give a much *softer* blast than the old method of the cylinder; while others, after having tried the fanners, have returned to the original and *stronger* blast of the cylinder. We cannot suppose that this is altogether fancy, or prejudice; I have no doubt that the differences of the material subjected to the blast, is the cause, in a great measure, of such opposite results.

At Lightmoor the various requirements of blast to make the best yield, with the different coals, were striking; coal No. 1, (of table I,) which is the best, required a considerably less dense blast than the inferior, No. 2, (yard coal.) Indeed, blast, either in volume or pressure, seemed to be of little consequence to the working of the clod coal—from 1¾ lbs. to 2¾ lbs. to the inch—the yield was not affected, the only difference being a slight increase of quantity. Nor did diffusing the blast by a number of tuyeres seem to make a material difference. It is a fact that, with this coal, and a furnace of ordinary dimensions, 60 tons of iron have been made in a week by *one blast pipe only*, the nozzle only 3 inches diameter, or 9 circular inches of blast.

On the other hand, the inferior, or, as they are called there, the "sulphury" coals, required a highly compressed blast to bring them to their best yield—one under 2½ lbs. to the inch gave very inferior results; compare this with Mr. Gibbons' result—his materials seem well adapted for cold blast working—and we find density of blast not a great object to them. 1 lb. 13 oz. only was his density at tuyeres, and this continued the same, although he doubled the capacity of his furnace.

These general facts seem to contradict the opinion, that the whole *rationale* of the effect of the hot blast is merely a decrease in the density of the blast, because, with the inferior material, which requires with *cold* blast the *greatest* density, the *hot* blast has the greatest and *best effect.*

Those who are acquainted with cold blast working, know that most materials work best with what is technically called a "snuff" at the tuyeres; and to form this it is usual to blow a few inches below the surface of the scoria, which floats on the iron in the hearth. The "snuff" is a kind of arched tube formed by the cinder at the end of the tuyere in the inside of the furnace, and through which the blast passes. Now it appears to me that this natural muzzle of cinder has a great deal to do in diffusing the blast in contact with the material; and, mark that those materials which, from inferiority, required blast

of the greatest density, gave the greatest trouble at the tuyeres, and presented practical difficulties in the "snuffing," which required a great pressure mechanically to overcome, and clear a way for the passage of the blast upwards; for *such* materials, from what cause I know not, always work with great uncertainty at the tuyeres—sometimes having a tendency to stop up entirely, at others not snuffing at all.

If this practical difficulty could be avoided, perhaps the bad material might give a better result with a soft blast than we found it to do.

As regards the blast's density, when used hot, it must of necessity be much less than cold; for the quantity of air injected from the blowing apparatus, is, generally speaking, no more with hot blast than with cold, while the area of the nose-pipes, taken together, is doubled, or trebled. The diffusion of the blast by increasing the number of nose-pipes, and disposing them around the hearth, has produced great increase in make; and in some cases, by this, together with increased shape, coals have been brought to work raw, which, with the first hot blast trials, could only be used when coked.

It seems agreed on all hands, the greater the number of the tuyeres around the hearth, the better; and as I am aware that practical difficulties occur in doing so by the furnace "blowing forward," I will state a simple plan by which we overcame the difficulty. In building our furnace we had a round base, as is now common, but instead of the usual four opening, we made five—one for the opening of the hearth, and *four for tuyeres.* By this method the blast from one tuyere does not blow against the other, and neither of them blow directly to the fore part; thus *eight tuyeres* may be used—two at each tuyere side.

More pressure is required even with hot blast to work some materials than others. For instance, we required but 2½ lbs. per inch in North Staffordshire, when working coke, but with coal, 3 lbs. per inch, with much greater heating surface, was required. The quantity of blast required here was very great. Blowing at four sides, we injected into a furnace fully 3000 cubic feet of air per minute, and heated to a high temperature. If this pressure happened at any time to be reduced, the effect was immediately perceptible, or if one of the tuyeres was taken off, a falling off in quantity and yield was the immediate consequence. The materials were, as I have before noticed, the worst I ever saw; both coals and iron stone being sulphury.

I will give only one other fact, a very extraordinary one, showing a most peculiar effect produced by a *simple increase of temperature,* at a work near Tipton, where the materials are of fair quality. The furnace upon which the experiment was made is only 11½ feet at "bosh," and 45 feet high, worked with raw coal, and hot blast; it produced 100 tons a week, being blown with five tuyeres, of 3 inches diameter each.

The cross pipes of the heating apparatus were four inches diameter, and one apparatus supplied all the tuyeres.

The alteration was this: the number of heating pipes was increased, the cross pipes increased in size from 4 inches diameter, to 7 inches diameter, and the main pipes also enlarged; the top of the furnace widened from 4 feet diameter to 7 feet diameter; the number of tuyeres increased from five to six, two on each side, and two at back, each of 3½ inches diameter; a new steam cylinder of greater power was put to the blast engine, but the blast one was kept at the same size.

The consequence is, that more than 150 tons of iron have been produced at this furnace in one week, with an improvement of yield, and the *engine goes no more strokes*, showing that actually no more *air* is forced into the furnace than when making only 100 tons a week, (two-thirds of present quantity,) although with a much greater area of nozzles.

TABLE No. II.

	Pressure in pounds.	Total area of nose pipes in circular inches.	Capacity of furnaces, cubic feet.	We'kly make of Iron.
COLD BLAST.				
Works near Glasgow,	3	12.5	2500	45 tns.
Lightmoor Works, with *bad* material.	3	15	2000	45 "
Same, with *good* material,	2½	12.5		65 "
Fenton Park, with *bad* material,	2½	12.5	1000	25 "
Corbyns Hall, Mr. Gibbons, *good* material,	2	18.2	4000	115 "
HOT BLAST.				
Works near Glasgow,	2¼	18	2500	60 "
Fenton Park Works,	2½	27	1000	40 "
The same, with different shape of furnace.	3	36	2500	70 "
Tipton, (a Work at)	2¼	45	2200	100 "
The same, with increased heating surface, but no greater *quantity* of blast.	2¼	72	2600	150 "

I give a short table of the pressure of blast, which shows that the quantity of blast bears no constant proportion to the capacity of the furnace, nor to the make. The results given from the Glasgow furnaces, are taken from data by M. Dufrenoy, in 1833; but since that period, the areas of nose pipes, and the number, and, consequently, the make, have been increased as at other places.

This table shows that the quantity of blast varies with different material to produce the same quantity of iron, especially with cold blast; with hot blast the *areas* bear little relation to the actual quantity of air injected, which cannot be arrived at without the capacity of the blowing cylinder, and speed of engines.

The tables and statements are much more general than I could have wished; at the same time I think they sufficiently show that, 1st. There is a remarkable difference in the material of different strata in the same coal fields; 2nd. That modification of shape and alteration of capacity have a very considerable effect; and 3rd. That the effect of blast is very various with different materials; that an alteration of its temperature, with certain coals, produces a saving of, in some cases, one-half, in others two-thirds of the quantity, while with other coals the difference is scarcely perceptible, and the quantity of blast has little relation to the quantity, or bulk, of material acted upon.

The improvements in iron smelting have been effected simply by the observation, and consequent successive trials, of practical men; they have been the result of no principle previously established—no theory obtained from the laboratory of the chemist—and further, I think it cannot be denied that the anomalies apparent under each condition into which I have divided my results, present a problem which, as far as chemical analysis has yet gone, it is difficult to solve. And it must surely be admitted, that had these conditions been previously laid down to any one well acquainted, theoretically, or practically, or both, with the manufacture of iron, together with a careful analysis of the material here referred to, he would never have predicated such results as have in reality accrued.

That the want of a guiding principle is greatly felt, and its attainment greatly to be desired, needs not to be set forth; and as there is no effect without a cause, I do not see that the number of apparent contradictions in these ought to make us, in the least, despair of ultimately attaining, by the powerful aid of science, a satisfactory rationale of the whole case. This, however, will never be done by avoiding the question—by taking a partial view of facts.

Glasgow Mech. & Eng. Mag.

On Artesian Wells. By Admiral Sir David Milne, G. C. B.

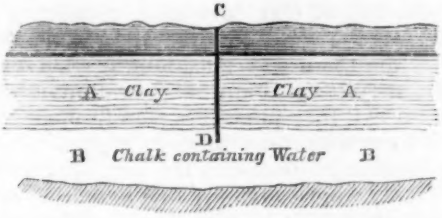
The theory of Artesian Wells, maintained by Buckland, Arago, and other first rate authorities, rests on a circumstance which seems to me liable to some doubt, and which I now mean briefly to consider, viz., the necessity of the water which ascends through the bore, having previously descended, or filtered through the earth, from some higher ground in the neighborhood.

But it is a well known fact, that in the vicinity of many artesian wells there are no hills at all, nor any particular elevation of the earth's surface; and the supporters of the now existing theory are driven to the necessity of seeking for these heights at any supposable distance. M. Arago, indeed, himself says, "that they must be sought for even beyond the sphere of vision, at the distance of forty, eighty, or hundred and eighty miles, or even more, if necessary."

Many years ago it struck me that a much more probable, and less complicated theory of artesian wells might be maintained, and which does not imply the necessity for there being any higher ground in the

neighborhood, none, indeed, at all higher than the mouth of the tube inserted in the bore for the supply of the springs.

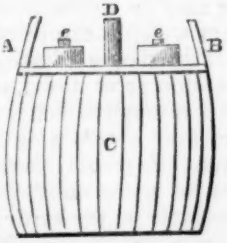
To elucidate my theory, let us suppose, immediately under the surface where the bore is made, a superincumbent mass of clay—such as the London clay—lying over chalk, or other formation, containing water. A diagram will more clearly show this.



A, denotes the bed of clay, a pipe is made to penetrate it from C to D, where it reaches B, a bed of chalk containing water. On known hydraulic principles it is demonstrative, that the instant the pipe C D, reaches the stratum, B, containing water, the water will be immediately forced up the pipe from the pressure of the superincumbent mass of clay, and will rise to the surface of the earth at the point C.

As another illustration, let us suppose that the bed of clay rested nearly horizontally on the lower strata containing water, and it will be seen that the same result would follow. The moment that vent was given by the bore to the water, it would be forced by the superincumbent weight to rise in the tube. The superincumbent strata will, as the water flows up, sink down, and continue to force up the water so long as any remains at the bottom of the bore. Indeed, the same reasoning applies to the continuance of the supply of water, even if we admit it as coming from a higher level. To support the latter theory, however, we have seen that it is necessary to admit the dubious fact, of the required water coming from heights sometimes at almost inconceivable distances; whereas, by the former, this difficulty is entirely got over.

The more distinctly to illustrate this, let us suppose a cask, or wooden box, C, filled with water, until it reaches the cover, A B, which is tightly fitted as a top. Then insert a hollow tube, D, through the cover, A B. When the pressure of the cover is increased by the addition of the weights, *e e*, the water will rise to the top of the tube, D, and it will continue to overflow as long as the pressure is made, or the supply continues. The same principles apply exactly to the rise of water, by superincumbent pressure, from the bed of clay. If it be argued against this theory, that the supply of water would, in time, cease, it may be answered, that the same argument obtains, and with equal force, against the other; for whether the water comes from a higher



level, or only from a free level, it should be remembered that it has been admitted by the best authorities, that artesian wells are sensibly affected by long continued droughts.

In confirmation of these views, and as a familiar practical illustration, I may be permitted to mention, that when the present basin was being constructed in Portsmouth dockyard, in 1796 or 1797, the piles first driven were 15 feet in length. From their length, these passed entirely through the bed of clay into sand containing water. The consequence was, that the water squirted up in all directions from the subjacent reservoir, and as it was uncertain to what extent the piles would sink, before they reached any solid stratum, it was resolved to shorten the piles, so that they might not pass through the clay at all; and the old holes were with some difficulty plugged up. Some years afterwards, the dockheads of one of the principal docks gave way, and sunk considerably; nor could any of the officers of the yard account for the occurrence. It happened at this very time, that, with the late Commissioner Sir George Grey, I was examining the docks; and, recollecting the circumstance which rendered it necessary to cause the piles to be shortened, namely, their having penetrated into the sand containing water, it occurred to me to ask Sir George if any wells were, at the time, being sunk in the neighborhood? His reply immediately was, that "certainly, workmen were then sinking for water near the officers' houses." Upon which I remarked, that if the sinking of the well was not stopped, other parts of the masonry of the docks would most assuredly give way; and that no wells should be allowed to be sunk near the dockyard, as, by giving vent to the water in the sand under the clay, the foundations of the buildings must necessarily be effected. This hint was, I believe, attended to, and the sinking of the well was stopped. In situations such as these, the insertion of a pipe through the clay would afford the supply of water with much more safety, the drain being less, and much more gradual.

Indeed, I can perceive no difficulty adhering, to the theory of artesian wells now propounded, which does not, with equal force adhere to the other; and it is free from many objections, to which it is liable. When we read, in Dr. Buckland, (p. 560,) when treating of this subject, that "by similar wells, it is probable that water may be raised to the surface of many parts of the sandy deserts of Africa and Asia," we may be well tempted to exclaim, "And where is the level there from which it can come?"

If the theory I have suggested be well founded, it must be obvious, that in a great town, or the neighborhood of it, built on a mass of clay, through which wells are sunk, there will be a constant, though probably a very slow and gradual, subsiding of the surface. Such situations would, therefore, be ill adapted for permanent observatories for astronomical purposes; as a subsidence of the ground, inappreciable on the earth itself, may produce sensible errors in observations of the heavenly bodies. May not some of the anomalous results obtained at observatories, be ascribed to this cause?

Edin. New Philos. Journ.

On the Results of the Panary Fermentation, and on the Nutritive Values of the Bread and Flour of different countries. By Robert D. Thomson, M. D., *Conductor of the Laboratory, and of the Classes of Practical Chemistry in the University of Glasgow.**

Several years have elapsed since the author first had his attention directed to the comparative chemical and medical values of fermented and unfermented bread as articles of food. The common idea, which yielded the palm of superiority to the former, did not appear to be based on solid data, and it was, therefore, considered desirable, that in reference to a subject of such importance to the nourishment of man, the arguments in favor of such an opinion should be subjected to a careful examination. Judging *à priori* it did not seem evident that flour should become more wholesome by the destruction of one of its important elements, or that the vesicular condition of bread could alone be gained by a process of fermentation.

When a piece of dough is taken in the hand, being adhesive, and closely pressed together, it feels heavy, and if swallowed in the raw state, it would prove indigestible to the majority of individuals. This would occur from its compact nature, and from the absence of that disintegration of its particles, which is the primary step in digestion. But if the same dough were subjected for a sufficient length of time to the elevated temperature of a baker's oven, (450°) its relation to the digestive powers of the stomach would be changed, because the water to which it owed its tenacity would be expelled, and the only obstacle to its complete division, and consequent subserviency to the solvent powers of the animal system would be removed. This view of the case is fully borne out by a reference to the form in which the flour of the various species of *Cerealia* is employed as an article of food by different nations. By the peasantry of Scotland, barley-bread, oat-cakes, peas-bread, or a mixture of peas and barley-bread, and also potatoe-bread mixed with flour, are all very generally employed in an unfermented form, with an effect the reverse of injurious to health. With such an experience under our daily observation, it is almost superfluous to remark, that the Jew does not labor under indigestion when he has substituted, during his passover, unleavened cakes for his usual fermented bread—that biscuits are even employed when fermented bread is not considered sufficiently digestible for the sick, and that the inhabitants of the northern parts of India, and of Affghanistan, very generally use unfermented cakes, similar to the *scones* of Scotland.

Such then being sufficient evidence in favor of the wholesomeness of unfermented bread, it becomes important to discover in what respect it differs from fermented bread. Bread making being a chemical process, it is from chemistry alone that we can expect a solution of this question. In the production of fermented bread, a certain quantity of flour, water, and yeast are mixed together, and formed into a

*Abstract of papers read before the Philosophical Society of Glasgow, 14th February, 1842, and 26th April, 1843; and now communicated by the author.

dough, or paste, which is allowed to ferment for a certain time at the expense of the sugar of the flour. The mass is then exposed in an oven to an elevated temperature, which puts a period to the fermentation, expands the carbonic acid resulting from the decomposed sugar, and the air contained in the bread, and expels the alcohol formed, and all the water capable of being removed by the heat employed. The result, gained by this process, the author considers to be merely the expansion of the particles of which the loaf is composed, so as to render the mass more readily divisible by the preparatory digestive organs. But as this object is gained at a sacrifice of the integrity of the flour, it becomes a matter of interest to ascertain the amount of loss sustained in the process. To determine this point, the author had comparative experiments made upon a large scale with fermented and unfermented bread. The latter was raised by means of carbonic acid generated by chemical means in the dough; but to understand the circumstances, some preliminary explanation is necessary.

Mr. Henry, of Manchester, at the end of the last century, suggested the idea of mixing dough with carbonate of soda, and muriatic acid, so as to disengage carbonic acid in imitation of the usual effect of fermentation; but with this advantage, that the integrity of the flour was preserved, and that the elements of the common salt required as a seasoner of the bread, were thus introduced, and the salt formed in the dough. Dr. Hugh Colquhoun, first, it is believed, carried this suggestion into practice, in 1826, and made numerous experiments on bread making.* But it was not till within a very few years, that the idea of using bread thus baked on a large scale was carried into execution. From the result of several experiments made at the author's request, it appears that upon an average there is a great loss sustained by flour when it is fermented. In comparison with the bread raised by carbonate of soda, and muriatic acid, there is a loss in the sack of flour of 30 lbs. 13 oz.; or, in round numbers, a sack of flour would produce 107 loaves of unfermented bread, and only 100 of fermented bread, of the same weight. Hence, it appears, that by the common process of fermented baking, in the sack of flour, 7 loaves, or 6½ per cent. of the flour, are driven into the air and lost.† An important question now arises from the consideration of the result of this experiment, viz., does the loss arise entirely from the decomposition of sugar, or is any other element of the flour attacked?

It appears from a mean of 8 analyses of wheat flour from different parts of Europe, by Vauquelin, that the quantity of sugar contained in flour amounts to 5.61 per cent. But it is obvious, that as the quantity lost by baking exceeded this amount by nearly 1 per cent., the loss cannot be accounted for by the removal merely of the ready formed sugar of the flour. We must either ascribe this extra loss to a conversion of a portion of the gum of the flour into sugar, and its

* Annals of Philosophy, N. S., vol. xii.

† In consequence of these and other facts brought forward by the author, the unfermented system of baking has been introduced into many of the unions in England, where, he believes, it has been found that he has not overrated the saving, which the above experiments would indicate to be upwards of a fifteenth.

decomposition by means of the ferment, or we must attribute it to the action of the yeast upon another element of the flour; and if we admit that yeast is generated during the panary fermentation, then the conclusion would be inevitable that another element of the flour, besides the sugar, or gum, has been affected. For Liebig has well illustrated the fact, that when yeast is added to wort, ferment is formed at the expense of the gluten, while the sugar is decomposed into alcohol and carbonic acid. Now, in the panary fermentation, which is precisely similar to the fermentation of wort, we might naturally expect that the gluten of the flour would be attacked to reproduce yeast.

The author has succeeded in forming a wholesome and palatable bread, by the employment of ammoniacal alum, and carbonate of ammonia, or soda, as a substitute for yeast. In this process the alum is destroyed by the heat; the bread is vesicular and white, and rises, according to the judgment of the baker, as well as fermented bread. It is obvious that none of the ingredients added can affect the integrity of the constituents of the flour, an occurrence which possibly may happen in the preparation of bread by the common process of fermentation, as has been shown, even to the azotized constituents. The disadvantage of such a deterioration is sufficiently evident if we view these principles as the source of nutrition in flour.

Lond., Edin. & Dub. Phil. Mag.

[NOTE.—The remaining portion of this article is devoted to a comparison of the value of different flours founded upon a chemical analysis; the result of which is that the flour from the United States falls far below all others in the quantity of nutritive matter contained in it—one of the European flours (Naumburg) being fifty per cent. more valuable. Would it not be worth while to inquire how far this result was affected by bone-dust, which, if our information upon this side of the Atlantic be correct, is a favorite adulteration in England and Scotland.] COM. PUB.

On the use of Larch Bark in Tanning. From an article on the "Examination of Astringent Substances, by J. STENHOUSE, Esq."

The bark of the larch is employed in Scotland to some extent in tanning. The quantity of tannin it contains is considerable, but the leather made with it is of inferior quality. The aqueous solution of the bark is strongly acid to test paper, and has at first a pale yellow color, which exposure to the air renders brownish-red; it gives a copious fawn colored precipitate with gelatine, but none with tartar-emetic. With the sulphate, chloride and nitrate of iron, it gives olive-green precipitates. Acetate of iron throws it down of a bluish-purple color. Sulphuric acid precipitates it of a reddish-yellow color. When boiled with the acid it dissolves, and the liquid assumes a fine scarlet color, like the infusion of Brazil wood. The altered tannin precipitates on cooling in beautiful red flocks, as it is but little soluble in cold water. It is very soluble in alcohol and alkalies, and its solutions

have a rich scarlet color, which is the most characteristic reaction of this species of tannin. Larch bark also contains a good deal of mucilage and resinous matter, Birch bark, alder bark, and tormentil root, contain, all of them, considerable quantities of tannin, which closely resemble that of larch bark. All these species of tannin are readily precipitated by gelatine, but not by tartar-emetic. They give olive-green precipitates with most of the salts of iron except the acetate, which throws them down of a bluish-purple color, which, on standing, changes to a leaden-grey. When boiled with alkalies they immediately assume a fine red color, but they differ from the tannin of the larch in not being reddened by sulphuric acid. I think it unnecessary to go into more minute details respecting them, as I have been unable to derive from them any determinate, or crystaline, compounds. I shall leave this subject, therefore, for the present with one or two general observations.

The great difficulty of examining the different species of tannin with a view to classifying them, is chiefly owing to their amorphous nature, to the great similarity of their properties, and to the circumstance, that, except in the case of nut-galls and shumac, the products of their decomposition are of a very indeterminate character. We think, however, that there are good grounds for believing that both nut-galls and shumac contain the same species of tannin, for the effects of reagents upon it are exactly the same, and the products of its decomposition, when boiled with either sulphuric, or muriatic, acid, when destructively distilled, or when left to spontaneous decomposition, are, in every instance, identical, from whichever of these sources it has been derived. It is remarkable also that in so many instances, in eight cases out of ten which I have examined, the species of tannin which give bluish-black precipitates with protosulphate of iron, are accompanied with larger, or smaller, quantities of gallic acid. In the present state of our knowledge it is impossible to say whether the gallic acid has originally existed in these substances, or has resulted from the decomposition of the tannin they contain. In the case of galls and shumac, the latter opinion is probable enough, as we are easily able to effect this change by artificial means, and it also, as is well known, occurs spontaneously. In the case of the other species of tannin, however, we are still unacquainted with any instance of a similar transformation. It is to be hoped that subsequent researches may yet throw light on this very obscure subject. It is also rather singular, that in the case of some of those species of tannin which give green precipitates with salts of iron, a somewhat similar circumstance occurs. Thus the tannin of catechu is accompanied by a crystaline acid body, catechine, which also gives green precipitates with salts of iron. I have likewise observed that in the case of infusions of birch bark, alder bark, &c., when the whole of the tannin they contain had been removed by gelatine, the clear liquid when filtered still contained a substance which precipitated salts of iron olive-green, just as the tannin had done, and which threw down salts of lead as copious dark yellow precipitates. When the lead salts were decomposed by sulphuretted hydrogen, I obtained an amorphous acid sub-

stance of a bright yellow color, which was soluble in water, alcohol, and æther, but which did not appear to be crystalizable.

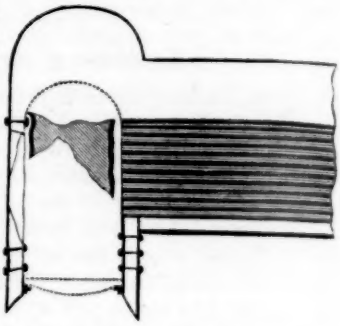
Ibid.

Explosion of the Telegraph Steamer.

This melancholy catastrophe—the most serious which has occurred upon the Clyde since the disastrous affair of the "Comet," in 1826—took place at the quay of Helensburgh, on Monday the 26th of March. The circumstances attending it are already widely and well known; but in order to preserve the facts, it may be briefly stated that the vessel had just landed her passengers from Glasgow and Greenock, and was in the act of backing out from the quay on her way to the Gareloch, when the disaster arrested her further progress. The engine had made one stroke, and was in the act of making a second, when, for a moment, a hissing noise was heard; this was followed, almost instantly, by a terrific crash of no comparable kind; and high in air, amidst volumes of steam and smoke, were to be seen the boiler, engine, funnel, and a thousand fragmentary portions of the unfortunate vessel and her furniture, commingled with human victims in one appaling picture of destruction. The engine and boiler, when they rose, turned over longitudinally, and, passing right over the heads of two men who were seated in a four-oared gig, waiting for the owner to come on board, fell into the water at a distance of 60 yards from their position in the vessel. They did not, however, instantly sink in coming into contact with the water, but skipped some length further along the surface, pouring forth, in the mean time, large quantities of steam. When the steam and smoke had cleared off, the vessel was found to be a total wreck, in the most literal sense of the term; among its broken timbers were to be seen the bodies of the dead and dying, and around, upon the water, were several survivors clinging to floating fragments of beams and boards. Immediately boats were out picking up the sufferers, and in a few minutes thirteen dead bodies, and as many severely wounded individuals, lay stretched in the rooms of the inn. Six more have since been added to the catalogue of the dead.

The construction of the Telegraph was quite a novelty even on the Clyde. She was clinker built, measured 120 feet in length, by 14 feet of beam, and was considered of 32 tons. Above and between the cabin and steerage there was a high elevation, on which was placed the wheel, so that the steersman, from his commanding situation, might keep a good look out; the helm was moved by chains running along the bulwarks, one on each side of the stern. Everything was contrived with a view to swift sailing—professedly, indeed, to compete with the Glasgow and Greenock Railway—and, in some measure, the expectations of her owners had been realized. Besides being herself of the lightest construction, she was propelled by an engine, which, with its boiler, weighed only eight tons; and was calculated, at a moderate pressure of steam, to work to 50 horse-power.

The whole was in imitation of the construction employed on railways, and worked, of course, on the high pressure principle. The boiler being a tubular one, as seen in the annexed figure, it was necessary to feed it with fresh water, and being unable to obtain fresh water by the pumps below Dumbarton, it was necessary to have tanks to contain a supply sufficient to furnish steam to carry her to Gareloch, where the tanks were again filled. The boiler was provided with three cocks, for ascertaining the quantity of water in it, besides a glass gauge; and had two safety-valves, both weighted by Salter's balance.



There has been much conjecture as to the cause which gave rise to the catastrophe. Some hold that it is to be attributed solely to the simple over pressure of steam, and the over loading of the valves; and others that it is to be ascribed to the water having been allowed to become too low, and the plates red hot, water being thrown upon these either by the feed-pump, or simply by the movement of the vessel, a sudden evolution of steam might take place, sufficiently powerful to produce explosion; or, according to another opinion, "the steam and water might be decomposed, and instantaneously generate a gas (hydrogen) possessing all the explosive force of gunpowder." The public verdict seems to have settled down between these latter hypotheses, into which it has been guided by the report of an examination of the condition of the boiler after the explosion, made, we are informed, under the direction of Mr. Rowand, of the Atlas Works, Glasgow, where the engine and boiler were made, and furnished by him to one of the local newspapers.* It proceeds:—"The accident has evidently been occasioned by the want of a due

* We have been informed that Mr. Rowand did not expect his name to appear in the report—that its appearance, in fact, was altogether an editorial blunder; but we really cannot sympathize with Mr. R. in that matter; if the investigation was carefully conducted, and the report faithfully given, there could be no harm in appending his name to the statement, as a guarantee to the public for its correctness. It is only under these circumstances that we can suppose Mr. R. to have lent his aid at all to put into circulation a report such as that quoted above; and although we cannot reconcile some statements in it, with the result of our own examination, we do not, for a moment, suppose that Mr. R. could have any intention of producing, even anonymously, a false opinion. It is, however, to be remarked, that it ought not to have been left to Mr. Rowand, or any other interested party, to report on the subject. It was the business of the local authorities to have appointed inspectors immediately on the fact of the disaster coming to their knowledge; and to have prohibited the removal, or disturbance of a single article, until a thorough examination had been leisurely and carefully gone through, and every fact noted, that could tend to elicit information as to the causes which led to the catastrophe. Somebody observes, that "occasional explosions" will occur; yet it is certainly very desirable that they occur as rarely as possible; and the way to make them less frequent, is to profit by the circumstances of all preceding instances. But if the facts are allowed thus to be obliterated, and glossed over without inquiry, or if they are allowed to be put forth in a form which gives them no practical bearing, the lesson is lost, and we are as ready as ever to take another. It may be said that such cases stimulate the tender

quantity of water in the boiler, as the plates in the crown, or cover, of the fire box have been red hot. On examination we find that the plates were riven completely across, as shown in the section above, the dotted line being the original position of the crown, and the heat has been so great that though the fire-box, or furnace, is only about 3 ft. 3 ins. wide, the plates are stretched, or expanded, so as to measure 4 ft.; and there are also on the plates several large blisters, which could only be the result of the intense heat. The violence of the explosion has been so great as to tear one of the corners of the fire-box a considerable way down, the plates at the corner being 5-8ths of an inch thick. The same rent goes through a solid bar 3 inches by 2. So far as can be seen, none of the tubes are injured. The fire-box was made of the best Lowmoor plate, of the following thicknesses:—Tube plate 5-8th inch, back ½ inch, crown 7-16ths. Tube and back plates welded."

That this report could have been published with a view to mislead public opinion, we cannot for a moment believe; yet a very careful inspection of the ruptured parts of the boiler leads us to a very different conclusion, as to the real cause of the explosion. That the plate forming the crown of the fire-box *had been heated*, we readily admit; it bears evidence of the fact; but that it was red hot at the instant of rupture, is inadmissible. On examining the blister marks upon the plate, we had no difficulty in concluding that the injury was of anterior date, and we were soon furnished with sufficient evidence that the cover had been "burned" at least twice previous to the catastrophe. This sufficiently accounts for the blister marks observed; and perhaps for the slight discrepancy between the thickness stated by Mr. Rowand, and that found by ourselves. In the report, it will be observed, the crown is given as a plate of 7-16ths, (when new?) whereas to us it barely measured 3-8ths, (that is, fully a sixteenth less,) *and we did not observe that it had been stayed.* By the way, is this usual in boilers similar in size to that of the Telegraph? In evidence of the heated condition of the crown, at the instant of rupture, it is stated in the report quoted, that the plates are stretched from three feet three inches to four feet. How Mr. Rowand came to such a conclusion, we cannot comprehend. As the crown, in its original position, formed a segment of a sphere, we can readily see that the linear measure of the ruptured plates would be greater than the chord which formed the diameter of the fire-box; and taking this into consideration, we

feelings of our nature, which might, without such salutary exercise, sink into dormancy. The circumstances, however, do not admit of levity; and we have certainly no inclination to indulge in any remark that might lead to the supposition that we regard the luke-warmness of the authorities, in this instance, as a matter of trivial importance; we look upon it as culpable negligence, admitting of no palliation. It is indeed stated, that "by direction of the authorities, certain professional men *are to* report to the sheriff on the subject." Allowing this statement to be well founded, it can hardly be taken in extenuation. Supposing these "certain professional men" to find their way, "by appointment," at some early day, to the quay of Helensburgh—what parts, or particles, of the exploded Telegraph remain for them to inspect? Every fragment has been assiduously picked up and removed, and the professional gentlemen are left to make up the best report they can, from such unprofessional opinions as they may be able to collect at second-hand.

have not the slightest hesitation in stating, that the superficial area of the whole cover is not increased a single inch.

There is, however, a more potent fact bearing against the opinion that the crown was in an intensely heated condition at the instant of explosion; the lead plug, put in for the express purpose of being melted before the plate could arrive at a dangerously high temperature, we found quite entire, and showing no symptoms of fusion. It is indeed believed, that when lead has been used under these circumstances for a length of time, it becomes oxidized, and requires a much higher temperature than 612° Fahr. to fuse it. It is for this reason, among others, that common solder is now used for such plugs, in preference to lead: it does not oxidate so speedily, and it fuses, moreover, at a lower temperature, and is, therefore, most decidedly to be preferred. On examining the plug, however, we found it far less oxidized than we had been led to expect. Whether it had been lately renewed we could not learn, but most certainly there was not oxide enough upon it to elevate its melting point ten degrees of Fahrenheit's scale.

But while we thus come to the settled conclusion, that the crown was not in a red hot state at the instant of explosion, we yet admit that it may have been over-heated within the range of temperature in which lead is solid; and that the explosion may, therefore, possibly be referable to a deficiency of water in the boiler. At the time we examined the boiler, it was ebb water, and the fire-box was quite exposed; but from the position in which the boiler itself was lying, we were unable to gain any information as to the state of the valves, and the amount of pressure at which they were weighted. This is not very much to be regretted, as, from the condition of the parts which we were able to examine, we had no difficulty in coming to the conclusion, that the explosion was caused by over-pressure of steam. The only inquiry which arises, is involved in the question—did this pressure proceed from an injudicious loading of the valves, or was such an amount of steam instantaneously generated, that, added to the amount already in the boiler, it produced a pressure too great for the cohesive strength of the crown plates?

That the explosion was the simple effect of over-pressure of steam, caused by over-loading the valves, might perhaps be argued upon the single fact, that during the slow working of the engine in approaching the quay of Helensburgh, and while remaining there, no steam was allowed to escape; and we believe that it was the practice, at all times, to raise the steam to a very high pressure in the boiler, before starting the engine. The fact of the steam being thus reserved, leads very directly to the conclusion, that a high pressure must have been accumulated in the boiler prior to the rupture taking place. Here, however, a question presents itself—why did the boiler explode when a portion of the steam was being withdrawn to set the engine in motion?—why not before, when the strain must have been more intense? These questions apply to nearly all recorded explosions of steam boilers. With very few exceptions, the rupture has immediately followed the admission of the steam upon the piston; and the

fact admits of a very easy explanation. On the exit of a portion of steam from the boiler, there is instantaneously generated a corresponding, or rather, there is reason to suppose, a greater quantity; for the undulatory motion given to the body of steam in the boiler, by opening the steam-cock, will, for an instant, withdraw a part of the pressure from the surface of the water, which will, so to speak, embrace the moment to send off an amount of steam corresponding to its temperature, and the amount of pressure removed. But the steam wave produced, in the first instance, in the direction of the steam pipe, being reflected back from the top of the boiler, must produce upon the bottom a greater pressure than before existed, when the whole contents were in a quiescent state. Add to this a quantity of steam, which we can easily suppose to be generated by waves of water laving high upon the heated sides of the boiler, consequent on the motion of the vessel; and there can be little difficulty in seeing why rupture may be produced under the circumstance of the engine starting, in a boiler already distended by steam, to the full strength of its vulnerable points. This explanation comprehends the celebrated case of the explosion of Messrs. Ferey's boiler, at Essonne, in France, which took place on opening the safety-valve, and likewise the explosion of two of Mr. Steele's three boilers at Lyons. In this case, these steamboat boilers were connected together, and the safety valve was fastened down to increase the pressure of steam. Shortly after one boiler exploded, and broke the connecting pipes. This, according to the received opinion—that by withdrawing a portion of steam, the pressure and danger are thereby instantly diminished—ought to have saved the other two boilers, by acting as safety-valves to them; they nevertheless exploded in succession.

With the facts before us of the retention of the steam, and the previously weak state of the crown plate—the only part of the boiler ruptured—there cannot exist much difficulty in comprehending the case before us. There is little necessity for supposing a deficiency of water in the boiler, and certainly none for supposing the crown to have been red hot at the time of rupture. It is true that the catastrophe may be explained on such a supposition—not by the decomposition of water, and the generation of hydrogen gas. We feel very confident that no case of explosion, under like circumstances, can be traced to such a cause. But, as already noticed, heated plates, by having a quantity of water laved upon them, readily give out their heat, and create an additional quantity of steam, and, in consequence, an additional aggregate pressure within the boiler. We are not, however, prepared to believe that the danger of over-heating boilers lies in the quantity of steam which is thereby produced on the admission of water;—the danger is to be apprehended from the suddenness with which it is produced. The heat even of red hot iron is small when viewed in connexion with the quantity of heat requisite to convert water into steam; but being a good conductor, it parts with its heat to the water with great facility, and under the conditions supposed, we can readily imagine that it will send off from its surfaee a volume of steam of great momentary elasticity. It is, moreover, to

be remarked, that a sudden development of steam in a boiler will exert its force, in the first instance, against the bottom; and it is only when this has sustained the concentrated shock without injury, that the force is reverberated, and allowed to distribute itself over the whole interior. Many cases of explosion, where a portion of incrustation had become loosened, and allowed the water suddenly to come into contact with an over-heated plate, may be referred directly to the instantaneous expenditure of the force at that point; and even under ordinary circumstances, the bottom—upon which the steam forms—sustains a greater amount of pressure than any equal superior surface.

Viewing the circumstances, therefore, as we may, we are brought to the conclusions, that the steam force due to the elasticity is expended upon the parts—the bottom and sides, in the first instance,—of a boiler before it comes to act upon the safety-valve, and in all cases where this valve is loaded to such an extent as to retain the steam within, at an elasticity approaching the cohesive strength of the weakest part of the boiler, any undulatory motion communicated to the mass of steam, or any sudden evolution of steam, from whatever cause the one, or the other, may arise, must be attended with great danger of explosion. This danger is thought to be lessened by employing more than one safety-valve, and by enlarging the capacity where one is only used, and there cannot be a doubt but that this is to a certain extent correct; there must at least be sufficient egress provided for the superfluous steam generated; but the only real safety lies in loading the valve—supposing it to be of moderate size—at a minimum of the proved strength of the boiler. To this condition add the no less important one, that the engines and boiler are under the management of trained, intelligent, and properly behaved engineers—men who know something more about an engine than "to put on and off the steam"—and we feel very confident, that disasters, such as that which has engaged our attention, will, in future, be very rare. This is a subject, indeed, which has long since been ready for legislative interference. Parliament is at length beginning to bestir itself in behalf of railway travelers; but the lives of steamboat passengers are equally precious: and surely if it be thought necessary that the engine-man, in the one case, should be able to satisfy a board of examiners, regarding his fitness for the duties incumbent upon him, we have an equal right to expect that those who may rather choose

"To steam it o'er the glassy wave,"

shall not be left to the care of men, whose fitness for their task is left to be judged of by persons, whose first consideration is the payment of the least possible amount of wages. Some have been calling out for the appointment of a government inspector at all our steamboat stations; we go a step further, and would place an accredited inspector in every vessel propelled by a steam engine.

Glasgow Mech. & Eng. Mag.

Description of an improved Tilting Apparatus for emptying Wagons at the termini of railways, shipping places, &c., as used at the Magheramorne Lime Works, Ireland. By JAMES THOMSON, Esq., F.R.S.E., M.R.I.A., F.R.S.S.A., Civ. Eng., Glasgow.*

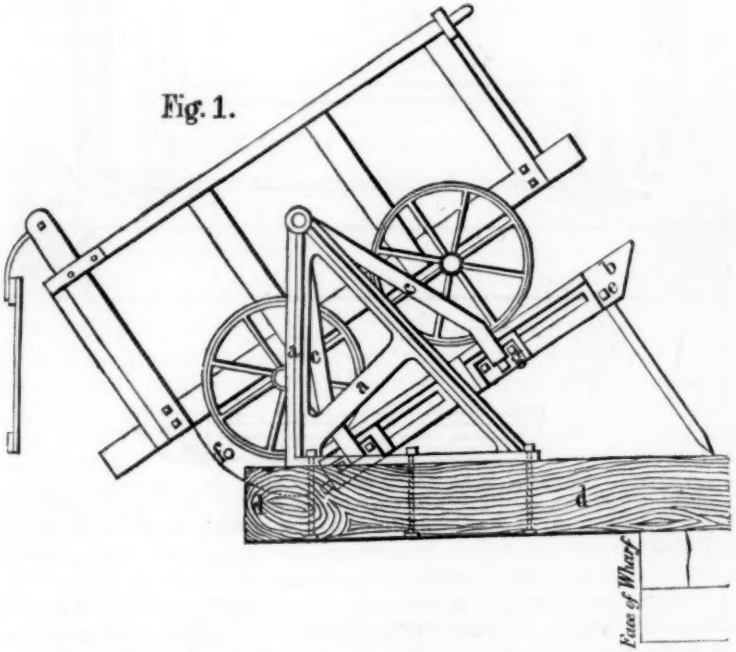
The apparatus may be generally described as consisting of three parts, viz:—

1st. The cast-iron brackets, or quadrants, for supporting the machine, *a*, *a*, *a*.

2d. The tilting-frame upon which the wagon is placed *b*, *b*; and

3d. The malleable iron-swings for suspending the frame to the brackets, *c*, *c*.

Fig. 1.



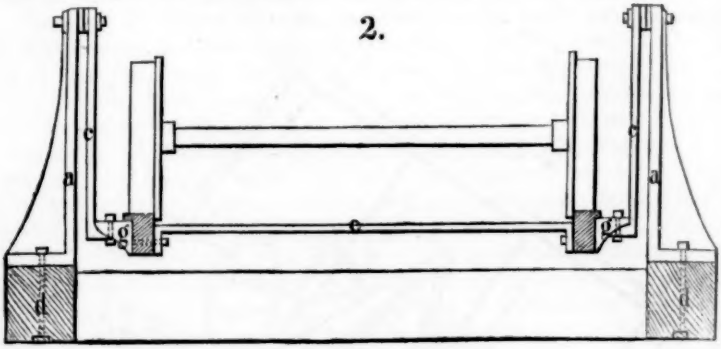
The supporting brackets, *a*, *a*, *a*, are bolted to the wooden frame, *d*, *d*, of a movable shipping platform, by means of which the apparatus is advanced at pleasure, and made to project beyond the wharf, so as to discharge the wagon immediately over the hold of the vessel.

The tilting-frame is formed of two cast-iron cheeks, or sides, as shown in fig. 3, having in each two slots, or grooves, for attaching to the swings, and for adjustment of the apparatus. These sides of the frame are connected together by two flat malleable iron stays, *e*, *e*, as represented in fig. 2, with two bolts in each end, and a light iron stay, *f*, at the curved ends.

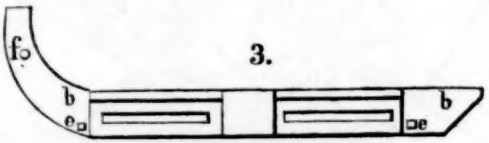
* Read before the Royal Scottish Society of Arts, and working model exhibited 10th of January, 1842, and the Society's Honorary Silver Medal awarded 14th November, 1842.

The swings are attached to the frame by means of snubs, *g*, *g*, which are bolted vertically to the lower ends of the swings, and horizontally to the sides of the frame, the bolts passing through the grooves, or slots, already mentioned, in which they are movable—the upper ends of the swings work upon malleable iron journals fastened in the top of the cast-iron brackets. When the apparatus is properly adjusted, which is done by moving the tilting-frame forward, or backward, upon the swings, by means of the adjusting slots, the wagon, on taking its position, should be so placed that its *centre of gravity may be slightly in advance of the point of suspension.*

2.



3.



The rails to the tilting-frame are laid with a gentle declivity, so that the wagon may be brought upon it with a slight impetus just sufficient to set the frame in motion—the wagon will then immediately fall into a position ready to discharge, as shown in fig. 2, when, by a simple contrivance, which may be effected in various ways, the door of the wagon is opened from behind by a handle and connecting rod communicating with the door latch, and the load discharged.

While loaded, the position of the wagon will of itself remain the same, being in equilibrio; but immediately after it is discharged, and consequently the *centre of gravity thrown behind the point of suspension*, the tendency of the wagon is then to resume the horizontal position, which, however, it is prevented from doing by means of the spur, *h*, until completely emptied—the spur is then disengaged, and the wagon resumes its level position ready to be removed.

The whole operation of discharging a wagon, of whatever weight, is effected with perfect safety and facility in a few seconds, and one very important desideratum is supplied by this apparatus, viz.,—the practicability of *discharging wagons of different dimensions and different sized wheels upon the same tilting-frame.*

The advantages of the apparatus have been fully tested at the Magheramorne Lime Works, in Ireland, where they were first applied, and have since been in constant operation for the last three years, discharging wagons of three tons with 24-inch wheels, and wagons of only 20 cwt. and 20-inch wheels, with perfect facility and expedition—the cost of each apparatus not exceeding from £10 to £11 complete.

Edin. New Philos. Journ.

Manufacture of Oil of Vitriol from Iron Pyrites.

The manufacture of sulphuric acid and soda is carried on conjointly, in a factory at Belgium, in the following manner:—The residua of the roasted pyrites are mixed with an excess of sea salt, having previously ascertained the contents of sulphate of iron contained therein. The mixture is then heated in an appropriate furnace, arranged so as to collect the muriatic acid. The sulphate of soda formed, is obtained by solution and crystalization; the peroxide of iron remaining is separated by elutriation into two parts; the most finely divided is dried and mixed with grease, or palm oil, serving as a lubricator for machinery, for which it is admirably adapted; whilst the coarser portions are made into balls, dried, and used as mineral iron for the puddling furnace. In factories where soda is not made concurrently with sulphuric acid, in place of procuring the sulphate of iron from the roasted pyrites, it will be more advantageous to distil these residua, the sulphate of iron being first dried, so as to obtain the fuming sulphuric acid of Nordhausen, as it is termed. It would be very easy to arrange the apparatus in such a manner that the sulphurous acid, arising from the decomposition of part of the sulphate of iron, should be conducted into leaden receivers, or chambers. By such an arrangement, nothing would be lost, since the colcothar, or peroxide of iron, remaining after the process has been completed, is always available.

Lond. Min. Journ.

An Enormous Steam Engine.

An enormous steam engine, by far the largest ever constructed, is now in process of manufacture at Harvey & Co's. foundry, Hayle; the piston-rod, which was forged last week, is 19 feet long, 13 inches diameter in the middle, and 16 inches in the core; and weighs 3 tons 16 cwt. It will work in an 80-inch cylinder, which will stand in the middle of another cylinder, of 144 inches diameter. Five other piston-rods will work between the inner and outer cylinders. We conclude, for this has not been explained to us, that the piston of the external giant cylinder will be perforated in the middle for the 80-inch cylinder to stand in it, and will work between the two. The 80-inch cylinder was cast last week, and the large one will be cast soon. The pumps are to be 64 inches in diameter; a measurement which may afford some idea of the size of the engine. It is intended for draining Hær-

lem Lake, in Holland, and it is expected that other orders for similar engines will be received from the same quarter. It is truly gratifying to us to observe that Cornish engineers still keep so far in advance of all the world, and not less gratifying to see that foreign powers know and can appreciate their excellence. Let this wonder of engineering and mechanical skill be considered, as well as the duty done by our common mine engine; and it must be confessed that our Cornish mechanics are, in this branch, far in advance of every competitor; and we may reasonably hope, as superior merit must be appreciated at last, that our engine foundries will at length have their full share of public and government patronage.

Sherb. and Yeovil (Eng.) Merc.

Bothway's Iron Blocks.

An experiment has been made in Plymouth dockyard, to try the comparative strength of Mr. Bothway's single metal blocks against the rope it is calculated to take, viz., a 3-inch one. A rope of that size was rove in the block, and one end brought to a windlass, and hove on until it broke. A 3½-inch was then tried; though larger than required for such a block, this also gave way; and the last is considered by practical men fully equal to the powers of an 8 or 9 inch block. The iron blocks have also another great recommendation in doing away with the rope strappings, as many serious accidents have occurred by their breaking.

Lond. Mech. Mag.

Street Sweeping by Machinery.

The first exhibition in the Metropolis of the self-loading cart, or street-sweeping machine, which has for some time been in use in Manchester, and is fully described in the "Mechanics' Magazine," No. 1014, took place recently on the wood pavement in Regent street, and attracted crowds of persons to view its very novel apparatus. The cart was drawn by two horses, and attended by a driver, and as it proceeded caused the rotary motion of the wheels to raise the loose soil from the surface of the wood, and deposit it in a vehicle attached to the cart. Proceeding at a moderate rate through Regent street, the cart left behind it a well swept track, which formed a striking contrast with the adjacent ground. It filled itself in the space of six minutes, its power being equal to that of forty men, and its operation being of a three-fold nature—that of sweeping, loading, and carrying at the same time, which, under the old process, formed three distinct operations.

Ibid.

An Artesian Well.

The artesian well at the Royal Hospital, Haslar, sunk by Mr. T.

Docwra, manager of the large artesian well now in progress for supplying Southampton with water, has resulted in producing a most abundant supply of water, which has been analyzed by order of the Board of Admiralty, and is found to be of the purest and softest quality. What is most surprising, is, that the water rises through 125 feet of shingle and running sand, which is full of salt water, being affected by the tides. The trouble and difficulty in stopping the salt water out has been entirely overcome. The quantity of water that Mr. Docwra guaranteed to obtain was 12,960 gallons per day, but the actual quantity obtained from the spring, 156 feet deep, was 59,328 gallons per day. This quantity can be pumped every day without reducing the water in the well more than about 40 feet from the surface.

Hamp. (Eng.) Ind.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of March, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

MARCH, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
2	9	38	*Im.* *h* Leonis,	6	91°	112°
2	10	46	Em.		328	327
4	17	11	*Im.* *e* Leonis,	4.5	78	30
4	18	22	Em.		328	278
10	13	46	Im. 1974 Bailey,	6	152	195
10	14	27	*Em.*		224	262
10	18	5	N. App. 33 Leonis,	7	☽ N. 0′.1	
21	6	33	*Im.* Bessel,	9	110	57
21	7	31	Em.		256	200
21	7	31	*Im.* Bessel,	8	132	80
21	8	37	Em.		232	182
23	5	22	*Im.* Bessel,	8	108	63
23	6	42	Em.		230	186
23	7	4	N. App. Bessel ☽ N 1′.6	9		
23	10	28	*Im.* Bessel,	8	130	85
	11	17	Em		229	183
23	10	31	*Im.* Bessel,	9	65	15
	11	24	Em.		284	241
30	13	38	*Im.* 6 Sextantis,	6	99	48
30	14	40	Em.		310	260
31	11	40	*Im.* *u* Leonis,	6	160	116
31	12	39	Em.		267	232

METEOROLOGICAL OBSERVATIONS FOR NOVEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P. M.	Baromtr. Sun Rise.	Baromtr. 2 P. M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
	1	28°	47°	30.25	30.20	NE.SE	Moderate		Clear.	Clear.
	2	45	50	29.72	29.72	W.	Brisk	1.10	Rain precg. ngt.	Clear.
	3	35	43	29.93	29.92	W.	Moderate		Clear.	Clear.
	4	29	41	30.03	29.95	NW.	do		Clear.	Cloudy.
	5	29	35	30.05	30.04	NW.	Brisk		Cloudy.	Clear.
	6	26	40	30.09	30.04	W.	Moderate		Clear.	Clear.
☉	7	31	33	29.88	29.80	NE.	Calm	.11	Cloudy.	Snow.
	8	33	41	29.80	29.82	W.	Brisk		Par. cloudy.	Par. Cloudy.
	9	30	39	29.80	29.87	NW.	Moderate		Clear.	Cloudy
	10	40	50	29.75	29.70	NW.	Calm	.08	Rain.	Cloudy.
	11	43	52	29.31	29.26	E.NW.	Brisk	1.30	Rain.	Cloudy.
	12	36	41	29.86	29 95	W.	do		Snow.	Clear.
	13	29	37	29.97	29.85	W.	Moderate		Par. cloudy.	Par. cloudy.
☽	14	27	35	30.11	30 09	W.	do		Clear.	Clear.
	15	27	43	30.20	30.15	SW.	Calm		Cloudy.	Clear.
	16	41	46	.0.00	29.97	E.	do	.43	Rain.	Cloudy.
	17	46	52	30.06	30.06	SE.	do	.14	Cloudy.	Rain.
	18	55	61	29.81	29.77	W	Moderate		Par. Cloudy.	Clear.
	19	38	50	29.98	29.97	W.	Brisk		Clear.	Par. cloudy.
	20	36	50	30.11	30.08	SW.	Calm		Clear—cloudy.	Rain.
⊗	21	44	44	29.61	29.53	E.	do	.73	Par. cloudy.	Rain.
	22	36	44	29.65	29.71	W.	Brisk		Clear.	Cloudy.
	23	30	49	29.88	29.85	W.	Moderate		Clear.	Clear.
	24	55	62	29.61	29.55	SW.	do	.06	Rain.	Par. cloudy.
	25	37	46	29.95	30.02	NW.	do		Clear	Clear.
	26	34	46	30.07	29.86	NW.	do		Clear.	Par. cloudy.
	27	29	32	29.94	29.97	NW.	Brisk		Rain—cloudy.	Clear.
☾	28	31	38	30.06	30.00	SW.	Calm		Clear.	Clear.
	29	32	33	29.80	29.66	E.	do	.12	Cloudy.	Rain.
	30	32	38	30.07	30.14	NE.	do		Cloudy.	Cloudy.
		35.47	43.9	29.91	29.88			4.07		

Thermometer. Max. 62.00, on 24th. Min. 26.00, on 6th. Mean, 39.70

Barometer. Max. 30.25 on 1st. Min. 29.26 on 11th. Mean 29.89

DECEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P. M.	Baromtr. Sun Rise.	Baromtr. 2 P. M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
	1	27°	34°	30.15	29.98	NE.	Calm	.21	Snow.	Snow.
	2	30	36	29.82	29.84	NE.	do		Cloudy.	Clear.
	3	30	34	29.95	30.00	N	do		Clear.	Clear.
	4	24	40	30.06	29.93	SW.	Moderate		Clear.	Cloudy.
	5	35	36	29.78	29.86	NW.	Blusteri'g		Par. cloudy.	Clear.
☉	6	19	30	29.70	30.03	N.SW.	Moderate		Clear.	Cloudy.
	7	28	31	29.68	29.56	SE.NW.	Calm	.65	Snow.	Snow.
	8	31	38	29 83	29.76	SW.	Moderate		Clear.	Clear.
	9	34	36	29.62	29.62	S.SW.	do		Cloudy.	Par. cloudy.
	10	24	32	29 92	30 03	SW.	do		Clear.	Clear.
	11	30	37	29 76	29.68	SW.S.	do	.02	Cloudy.	Rain.
	12	29	36	29.74	29.85	NW.	Brisk.		Clear.	Par. cloudy.
	13	14	22	30.44	30.50	NW.	Moderate		Clear.	Clear.
☽	14	15	33	30.48	30.42	SW.	do		Clear.	Clear.
	15	29	41	30.33	30.28	SW.	Calm		Par. cloudy.	Clear.
	16	35	42	30.16	30.00	E.	do		Misty.	Rain.
	17	36	40	29.84	29.83	N.	do	.42	Rain.	Cloudy.
	18	34	39	29.95	30 04	E.W.	Moderate		Cloudy.	Par. cloudy.
	19	33	40	30.15	30.13	W.	Calm		Cloudy.	Cloudy.
	20	32	44	29.95	29.92	NW.W.	Moderate		Clear.	Clear.
⊗	21	33	43	30.20	30.15	W.	Calm		Clear.	Cloudy.
	22	37	40	29.88	29.67	NE.	do		Cloudy.	Rain.
	23	36	36	29.82	29.88	E.	do	.86	Rain.	Cloudy.
	24	34	40	29.93	29.86	SW.	do		Cloudy.	Cloudy.
	25	34	42	29.95	29.95	SW.	do		Cloudy.	Cloudy.
	26	38	42	30.05	29 94	E.	do	1.30	Cloudy.	Rain.
	27	36	42	29.76	29.76	SW.W.	do	.26	Cloudy.	Clear.
☾	28	38	42	29.73	29.58	E.	do		Cloudy.	Rain.
	29	32	34	29.67	29.67	W.NW.	Brisk		Clear.	Clear.
	30	29	34	29.69	29.69	NW.	Blusteri'g		Clear.	Clear.
	31	30	36	29.73	29 68	N·	Brisk		Clear.	
		30.52	37.16	29.92	29.94			3.7		

Thermometer. Maximum 44.00 on 20th. Minimum 14.00 on 13th. Mean 33.84

Barometer. Max. 30.50 on 13th. Min. 29.54 on 7th. Mean, 29.93